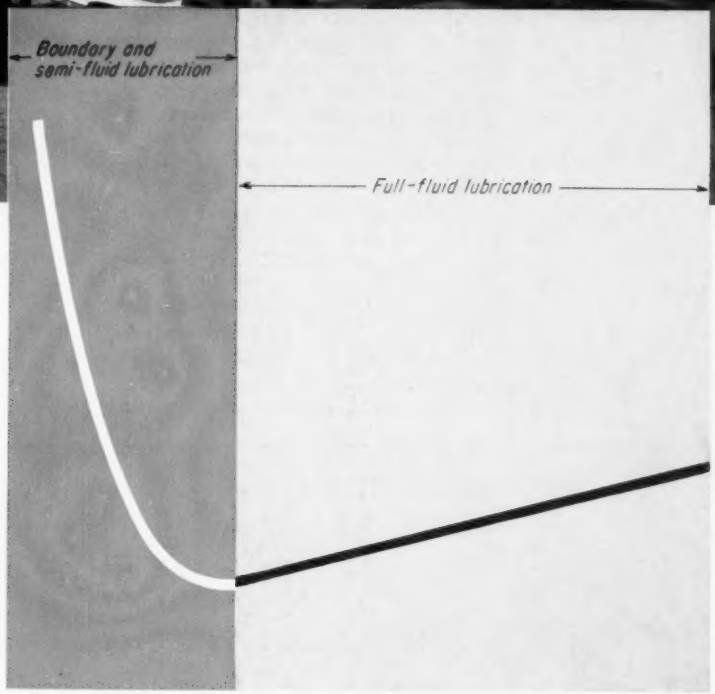
For engineers who design and manage the power and plant services

Power

NOVEMBER 1958

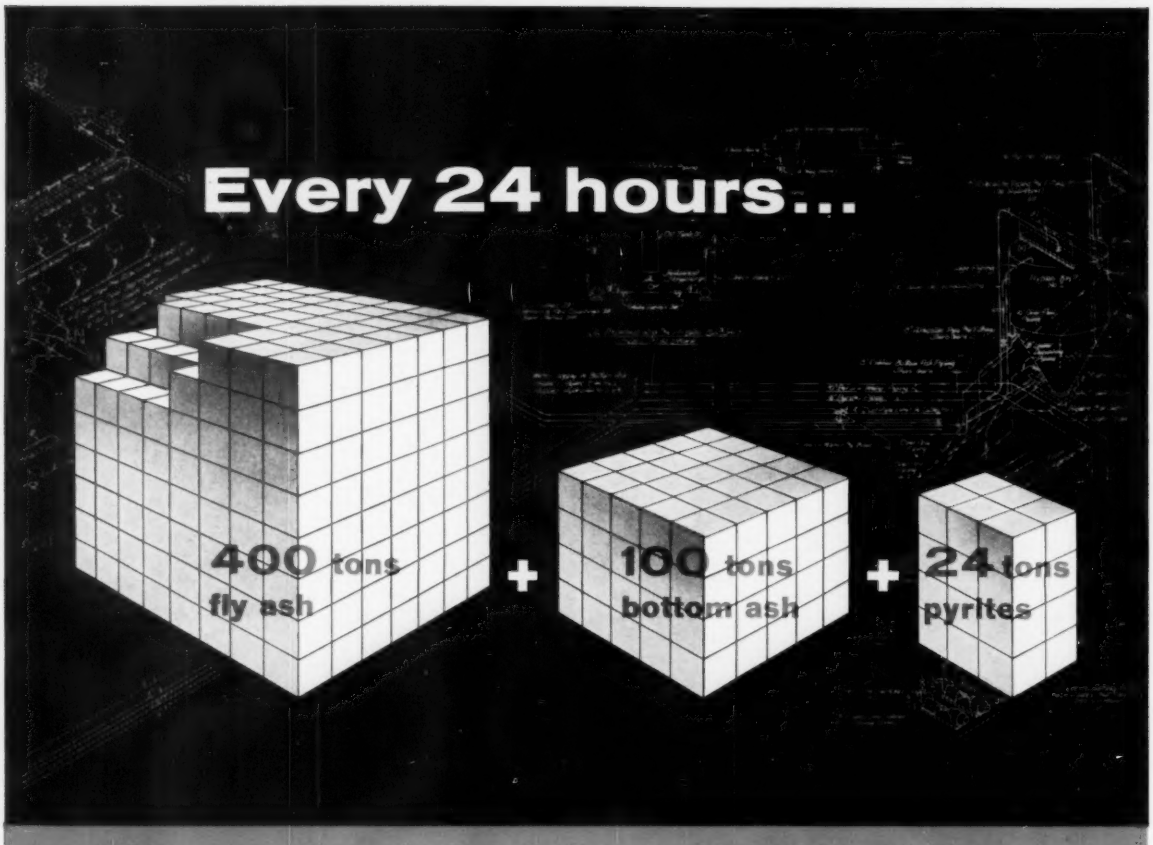
ONE DOLLAR

A McGRAW-HILL PUBLICATION



a *TD* report:

Why today's solid lubes show new promise ▸ 77



will be removed and transported 900 feet at the new Eddystone Station, Philadelphia Electric Co.

A progressive step in power production will be realized next year when Philadelphia Electric's Eddystone Station goes into operation. Utilizing pressures and temperatures never before attempted (throttle steam condition for the first unit will be 5,000 psi—1,200°F.), the two units to be installed will produce 325,000 kilowatts of electricity each. This will be accomplished with coal consumption of *less than 2/3 pound per kilowatt hour.*

The problems of ash and pyrites handling for the Eddystone Station were solved by The Allen-Sherman-Hoff Company. The systems are completely automatic, with storage at a point about 900 feet from the plant. Ultimate disposal will be by rail car, truck or barge.

Bottom ash will be collected in water-filled hoppers and pumped to dewatering bins. This system will be completely closed; there will be absolutely no run-off water and make-up water will be held to a minimum.

Fly ash will be removed by four independent systems (each boiler is divided into half, each with its own system). Vacuum will be produced by water jet pumps, the water recirculating as part of the system.

Pyrites will be transported by a high pressure hydraulic system and discharged to either of the dewatering bins, where it will be handled with the bottom ash.

Few ash handling systems are this large, but *your problem, whatever its size, will be given the same careful consideration as is going into this installation.* Contact us today and gain the advantages of our many years experience in solving ash handling problems of all sizes.

A-S-H service doesn't stop with installation. When service problems come up, we stand ready to give prompt service assistance. This is a policy worth considering when suppliers are being selected.

MATERIALS HANDLING SYSTEMS

"Hydrojet" *hydraulic*

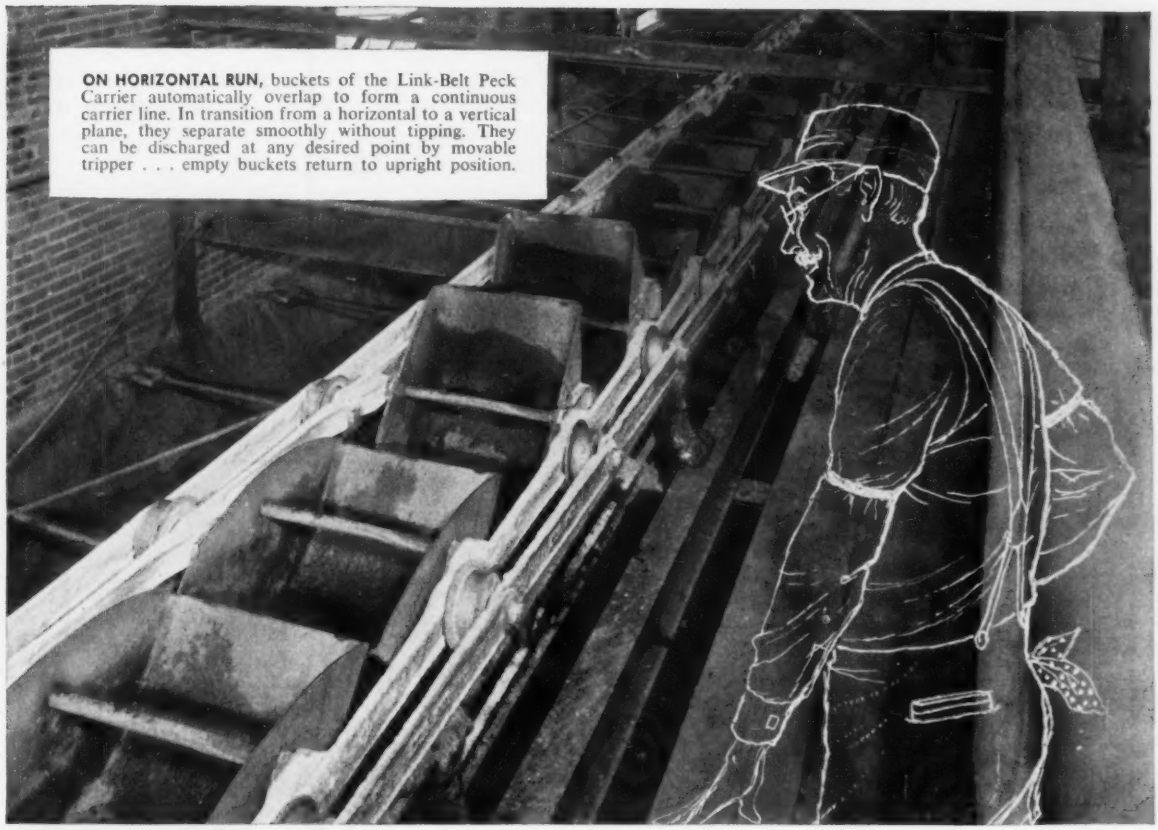
"Hydrovac" *pneumatic*

the **Allen-Sherman-Hoff** company

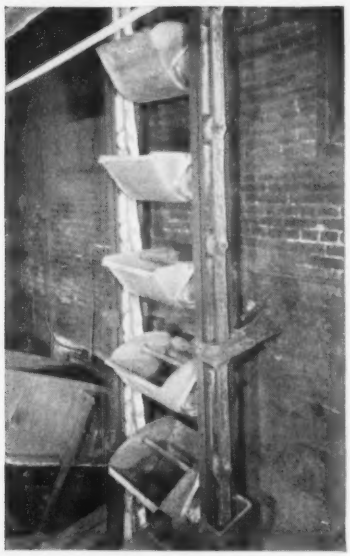
259 E. Lancaster Ave., Wynnewood, Pa.

Offices and representatives in principal cities

55 years, 3 million tons of coal
...and still going strong



ON HORIZONTAL RUN, buckets of the Link-Belt Peck Carrier automatically overlap to form a continuous carrier line. In transition from a horizontal to a vertical plane, they separate smoothly without tipping. They can be discharged at any desired point by movable tripper . . . empty buckets return to upright position.



UP TO BUNKERS. Peck Carrier at South Shops of L. & N. R. R. in Louisville, Kentucky, first elevates coal to top of bunkers, then carries it horizontally to discharge points. Carrier also serves as an ashes handling system—from furnaces to ashes bin.

LINK-BELT Peck Carrier installed in 1903 still uses original chain and drive

In a half century of service, the Peck Carrier at the South Shops of the Louisville and Nashville Railroad Company has traveled an estimated 52,000 miles. Yet it performs as efficiently today as in 1903—still uses the original chain and drive . . . half of its original buckets.

The durability demonstrated here makes Link-Belt's Peck Carrier the low-cost answer for moving coal both vertically and horizontally over the same route year after year. It can travel any combination of paths . . . permits continuous flow of coal from unloading to storage without need for transfer points. This combination elevator-conveyor consists of pivoted buckets suspended between two strands of chain. Buckets are mounted to remain upright except when dumping. Especially important: coal never comes in contact with rotating pins, bushings, rollers of the chain.

For full information on the complete line of Link-Belt coal handling equipment, call your nearest Link-Belt office. Or write for Book 2410.

LINK-BELT

COAL HANDLING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14.920

DE LAVAL
IMO PUMPS

are now more versatile than ever

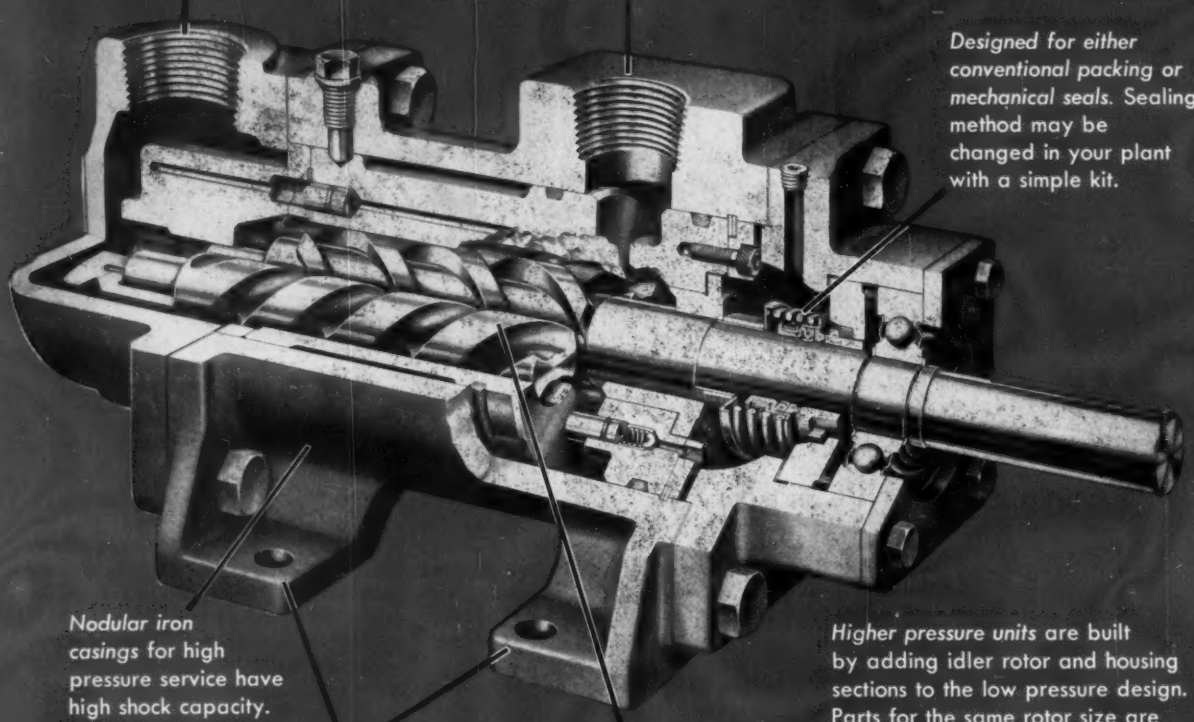
De Laval IMO pumps have proved that they do a dependable job over long years of service. The reason is IMO design simplicity. These constant displacement rotary pumps have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no timing gears, cams, valves, sliding vanes, or reciprocating parts to wear or become noisy. *Quiet*, compact IMO pumps are excellent for direct-connected, high-speed operation.

In addition to these basic pumping advantages, the improved IMO gives you important new benefits shown in the cutaway illustration below.

DE LAVAL IMO PUMPS can also be used as hydraulic motors.

Inlet can be rotated to suit installation arrangement.

Discharge flanges are infinitely varied. You can use the most advantageous piping method to suit installation requirements.



Designed for either conventional packing or mechanical seals. Sealing method may be changed in your plant with a simple kit.

Nodular iron casings for high pressure service have high shock capacity.

Any position mounting is possible without factory modification.

Higher pressure units are built by adding idler rotor and housing sections to the low pressure design. Parts for the same rotor size are interchangeable over the entire pressure range.

Internal parts are designed as a package so that units can be built into your machines.

Bulletin 3001 gives data on improved De Laval IMO pumps. Send for your copy today.

DE LAVAL *IMO Pumps*

DE LAVAL STEAM TURBINE COMPANY
815 Nottingham Way, Trenton 2, New Jersey

DL 418

In Power this month

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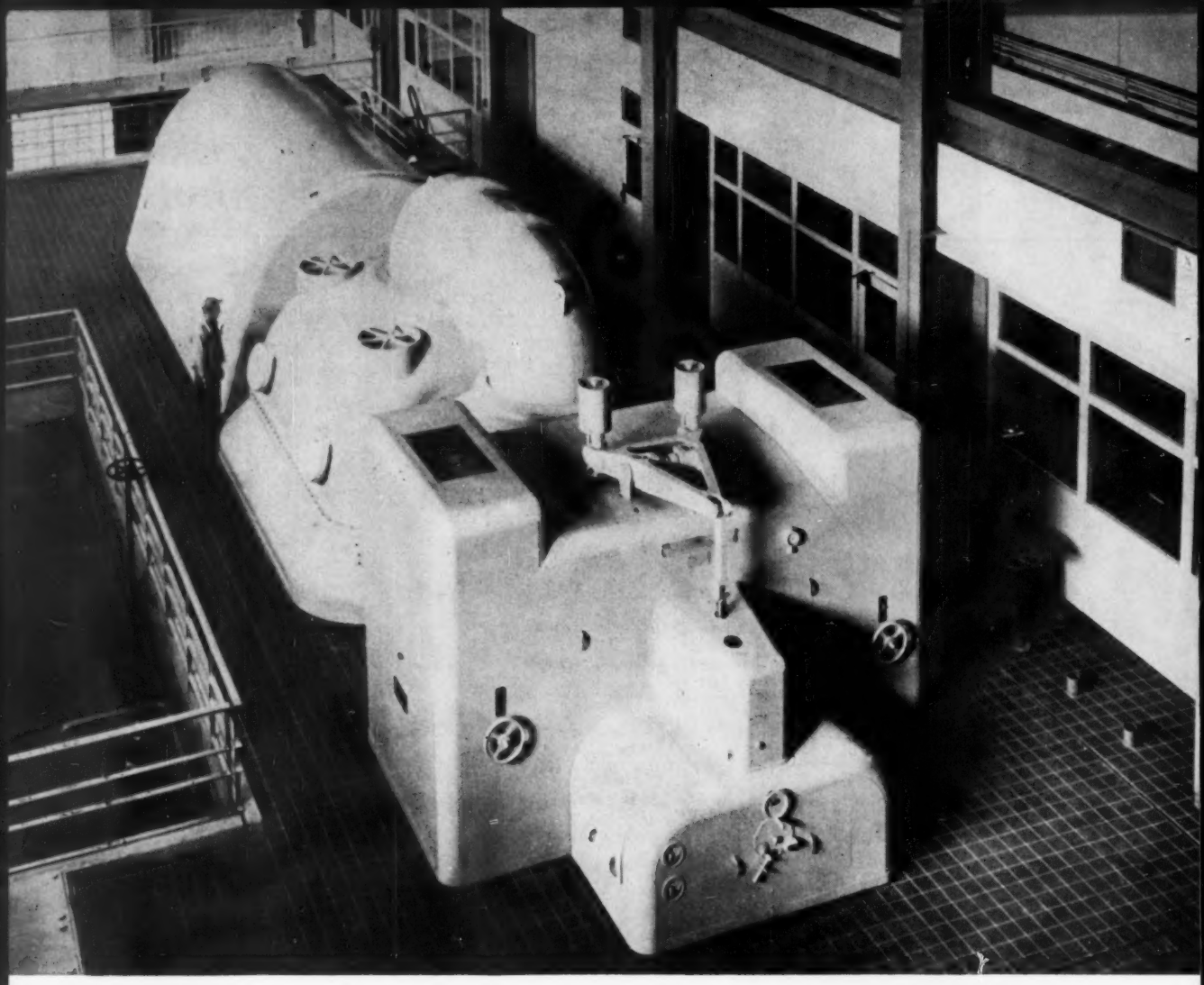

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There's extra service built into Texaco Regal Oil R&O because it gives dependable protection against rust and oxidation as it lubricates. It's a first rate lubricant fortified with extra resistance to the formation of rust, sludge and foam.

The additives in Texaco Regal Oil R&O keep systems clean. The oil circulates freely throughout an extra-long service life. The bearings stay cool and the governor runs steadily and dependably.

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W K PONDER — Circulation Manager

Power • November 1958 • Vol. 102—No. 11

speaking of Power

Nuclear energy seminars are back as an off-page POWER service. Designed specifically for management men among power-field equipment manufacturers, these 2-day invitation meetings are a continuation of the service introduced in October 1955. At that time POWER editors set the pattern for future meetings: a review of atomic energy fundamentals, a survey of current developments, a discussion of possible future nuclear advances.

This month power-field excutives will meet in New York and Chicago for another up-to-the-minute briefing by POWER editors. One-day refresher sessions will also be held in both cities to keep seminar grads in tune with the latest developments.

The *TD* report in this issue (*Solid Lubricants*, p 77) is the seventh *Today's Development* report published in POWER during 1958. Like the first *TD* on electronic computers (Jan 1958, p 71), each of these staff reports explores a part of the power-service field where technical advances are coming fast. Each rounds up events and developments that promise to influence tomorrow's practice. You can look forward to more of these reports as a continuing feature during 1959.

Staffer Bob Bellas has been promoted from Assistant to Associate Editor. During his years as an assistant editor, Bob has skillfully blended a rich engineering background with top writing ability. One recent example: The well-received 24-page special report on packaged boilers (Aug 1958).

Water supply and treatment will become even more important tomorrow, reports Assistant Editor Bob Marks. Many in the equipment and service phase of the water business are gearing up now for the growth years ahead. Typical signs: Hall Laboratories have recently moved into their new technical and administrative quarters on the outskirts of Pittsburgh; Nalco has added a wing to their existing facilities.

This comment came about because Bob Marks is smack in the midst of a 32-p special report (Part I) on water treatment for the December issue. Second part of this most significant report will be published in March 1959.

Lou Lowley

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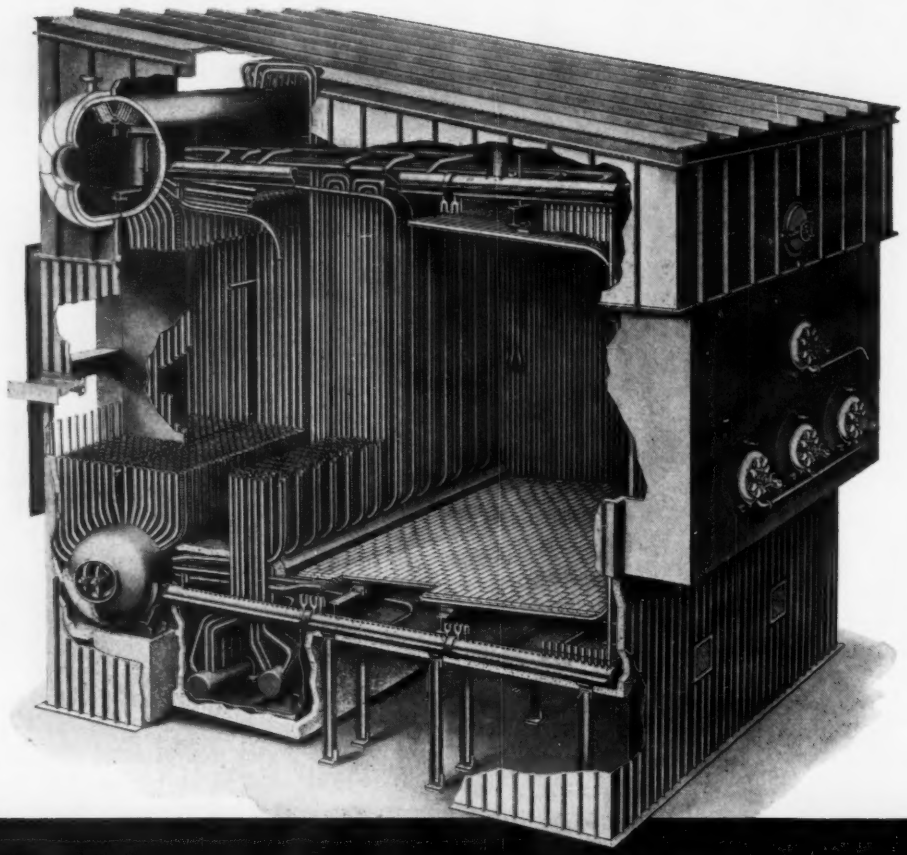
Designed For Tomorrow's New, Economical



HERE ARE 8 WAYS IN WHICH THE PFI BOILER CAN BE OF BENEFIT TO YOU:

1. It requires a minimum amount of space for a given power output.
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8. All-welded Membrane Wall contributes to high efficiency and reduces insulation requirements.

Plants Power For Industry

New B&W PFI Oil-Gas Burning Unit Provides Maximum Output in Minimum Space

Here's an answer to industry's need for an economical, dependable steam supply. The new B&W Integral-Furnace Boiler produces high-quality, dependable steam economically at all ratings. Aptly named the PFI, the "Power for Industry" Boiler is compact, easy to install, quick to meet rapid and wide load swings. The new boiler gives long, sustained operation, requires little attention and is readily accessible for inspection, cleaning and maintenance.

All responsibility for your complete delivered and erected unit is accepted by one experienced, dependable source which in the past 25 years alone has placed over 4,000 Integral-Furnace Boilers in service. Behind *every* B&W Boiler is nearly a century of leadership in steam generation. A national network of B&W plants and engineering facilities means that the special skills of B&W engineers are always quickly available to you for service and assistance. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

For further information about the B&W PFI Boiler, write for Bulletin G-94.

BABCOCK & WILCOX

BOILER DIVISION

G-899

IMPROVED BLOWER NOZZLE and

more important features of the

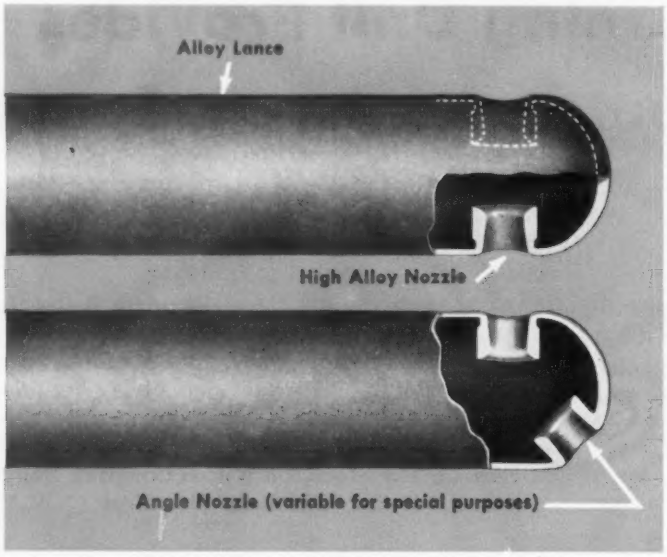
New **Diamond** Series 300 IK

LONG RETRACTING BLOWER

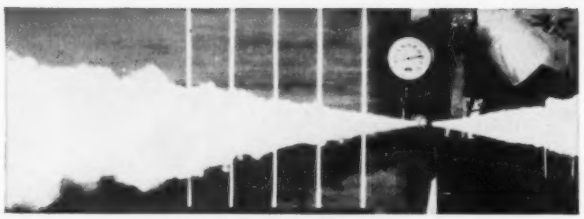
This improved nozzle provides more available cleaning energy per pound of steam or compressed air. A modified venturi, it is the result of extensive research during which more than 50 contours were tested.

The positively-controlled, close helical cleaning pattern assures optimum coverage of the heating surface. Return travel path is exactly intermediate to forward travel path . . . resulting in a positive nozzle sweep every inch.

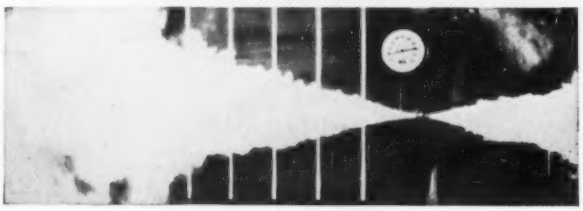
These features are two of many reasons why the Diamond Series 300 IK Blower does a better and more economical job of cleaning surfaces which require a long retracting blower. Other advantages are listed at the bottom of the opposite page. Ask the nearest Diamond office for Bulletin 2111U which will tell you much more about the new Series 300 IK.



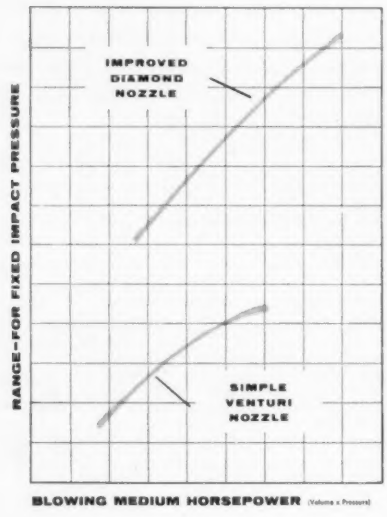
Improved Diamond Type "A" Nozzle has low approach velocity for optimum nozzle performance (see curves below). It provides greatest impact for any given blowing pressure . . . means greater effectiveness and economy.



IMPROVED DIAMOND NOZZLE

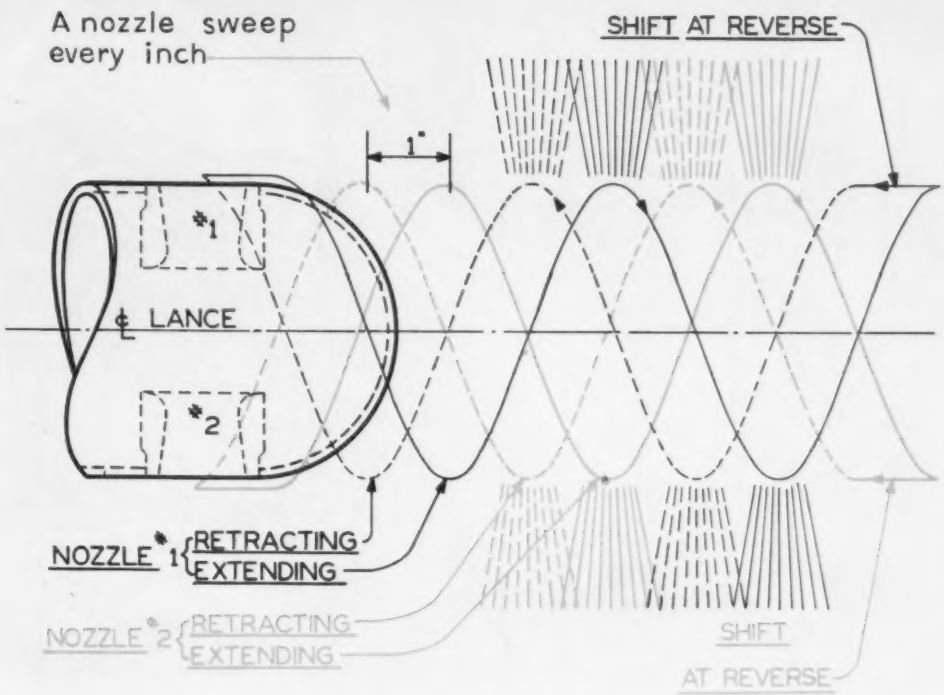


7818A SIMPLE VENTURI NOZZLE

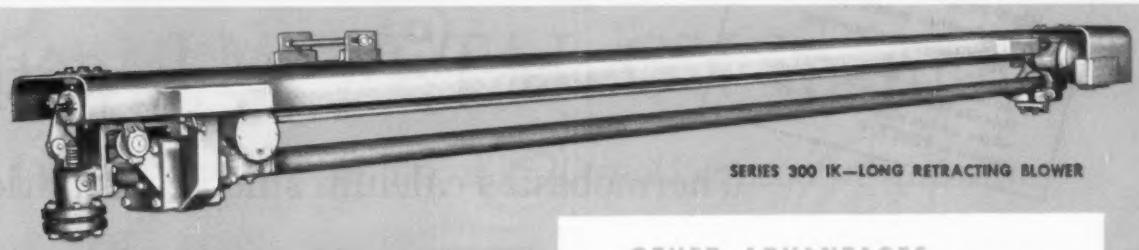

IMPROVED DIAMOND NOZZLE
SIMPLE VENTURI NOZZLE
RANGE—FOR FIXED IMPACT PRESSURE
BLOWING MEDIUM HORSEPOWER (Volume x Pressure)

Note the greater blowing range of the improved Diamond Nozzle when compared with a simple venturi nozzle under identical test conditions.

IMPROVED CLEANING PATTERN



Nozzle-sweep-every-inch blowing pattern assures COMPLETE coverage of ALL surface EVERY time



SERIES 300 IK—LONG RETRACTING BLOWER

Diamond DIAMOND POWER SPECIALTY CORPORATION

LANCASTER, OHIO

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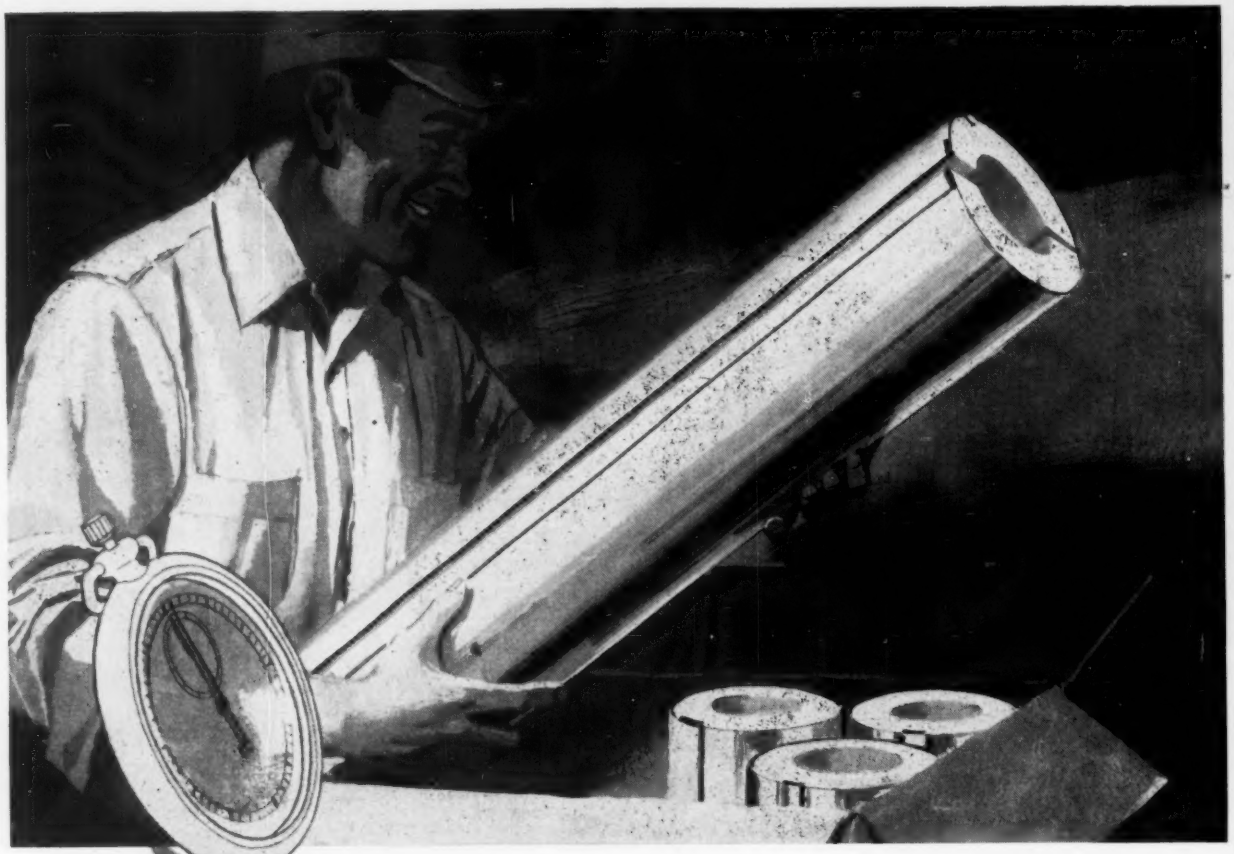
No other blower gives you all these advantages.



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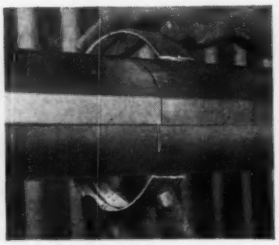
- **A protective metal jacket**
- **A built-in vapor barrier**

The insulation in Metal-On is Johns-Manville Thermobestos® . . . finest of all the calcium silicate insulations for service to 1200°F.

From carton to . . . with

Thermobestos calcium silicate insulation

5 SECONDS TO REMOVE Metal-On from carton. Another 25 seconds to snap on pipe and lock in place!



15 SECONDS LATER the specially designed aluminum "snap strap" (containing vapor seal) has been snapped on joint.

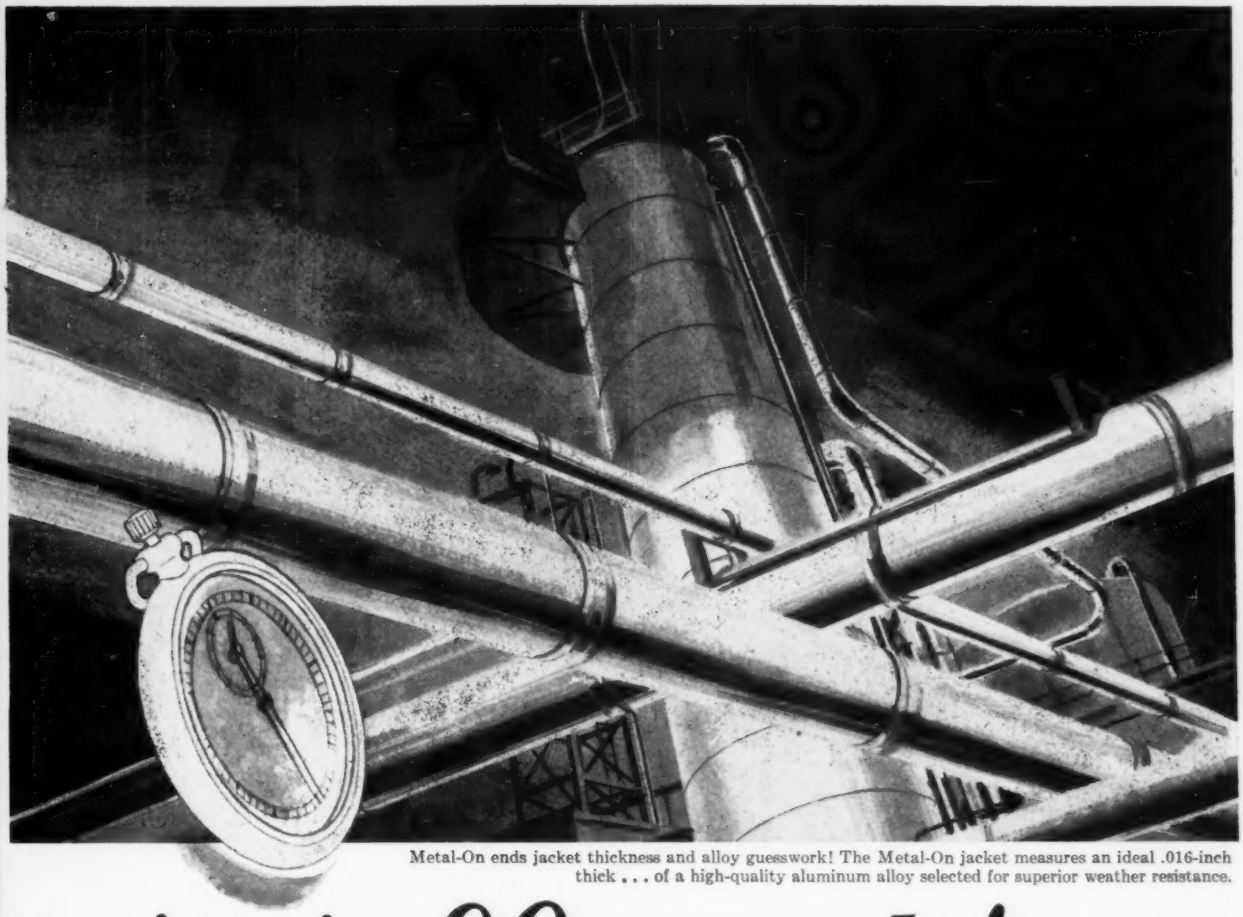
METAL BAND provides perfect joint protection against vapor and weather. Total elapsed time: 90 seconds!

Here's the fastest, most efficient way ever to install high-temperature pipe insulation and protective aluminum jacketing.

Metal-On is the insulation idea all industry has asked for: a single package product that permits application of Thermobestos pipe insulation and corrosion-resistant metal jacket in one fast operation. You'll find that a section of Metal-On can be applied as fast as, oftentimes faster than, an insulation alone.

Snaps in place . . . F-A-S-T!

J-M's new Metal-On consists of Thermobestos calcium silicate insu-



Metal-On ends jacket thickness and alloy guesswork! The Metal-On jacket measures an ideal .016-inch thick . . . of a high-quality aluminum alloy selected for superior weather resistance.

pipe in 90 seconds!

new J-M METAL-ON Insulation!

factory-jacketed in gleaming, weatherproof aluminum

lation, a vapor barrier and an all-weather protective covering of aluminum. Furnished ready-to-install, a section of Metal-On snaps on the pipe, locks tightly in place (new locking device is exclusive Metal-On feature) to seal out weather and protect the insulation indefinitely. Joints are sealed tight with aluminum "snap straps" mechanically fastened in place with metal bands.

Right alloy . . . proper thickness

The Metal-On aluminum jacket reduces maintenance in virtually every outdoor pipe application! It never needs painting . . . won't rust . . . is impervious to surface dirt, oils and grime. The jacketing is made of an aluminum alloy (containing magnesium) that is specially selected for superior corrosion resistance. Jacket thickness is designed to provide, at lowest cost, outstanding appearance, stiffness, workability and resistance to abuse and pitting.

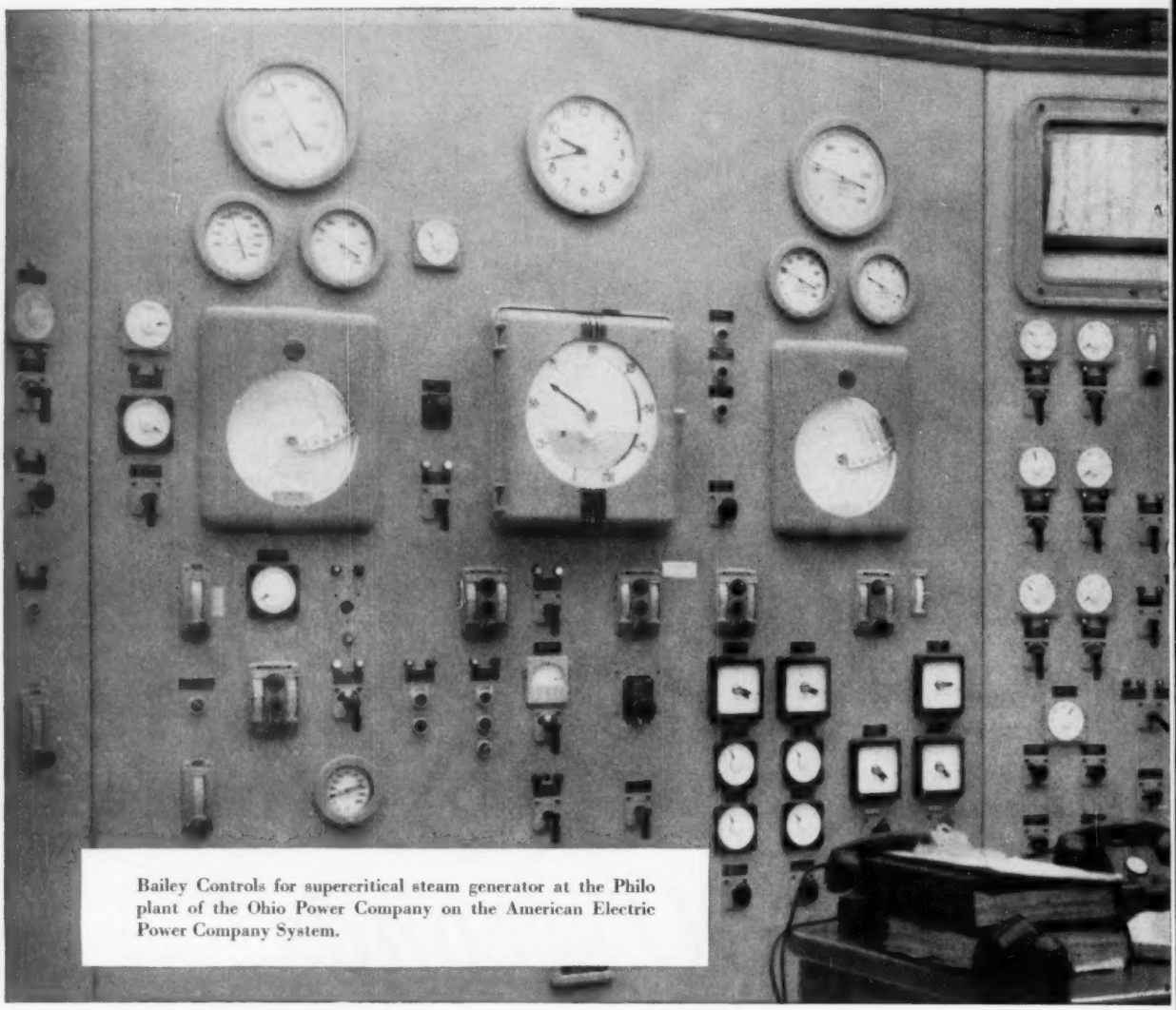
Metal-On presents no fitting problem. It is cut easily right on the job with either power or hack saws. Available in 36″ sections in a complete range of pipe sizes through 24″ . . . by 3″ thickness.

To help you investigate Metal-On for your next pipe insulation requirement, let us send you the informative brochure, IN-217A. Write for it today. Address Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE

100 YEARS OF QUALITY PRODUCTS...1858-1958

JOHNS MANVILLE JM PRODUCTS



Bailey Controls for supercritical steam generator at the Philo plant of the Ohio Power Company on the American Electric Power Company System.

Bailey pioneers the control of...

This is the control center for the first commercial supercritical pressure, steam-electric unit in America. It went into operation March 20, 1957. Tests made during the first year of operation indicate that this new high pressure unit, with Bailey Controls, is establishing new efficiency records in the conversion of coal to electricity.

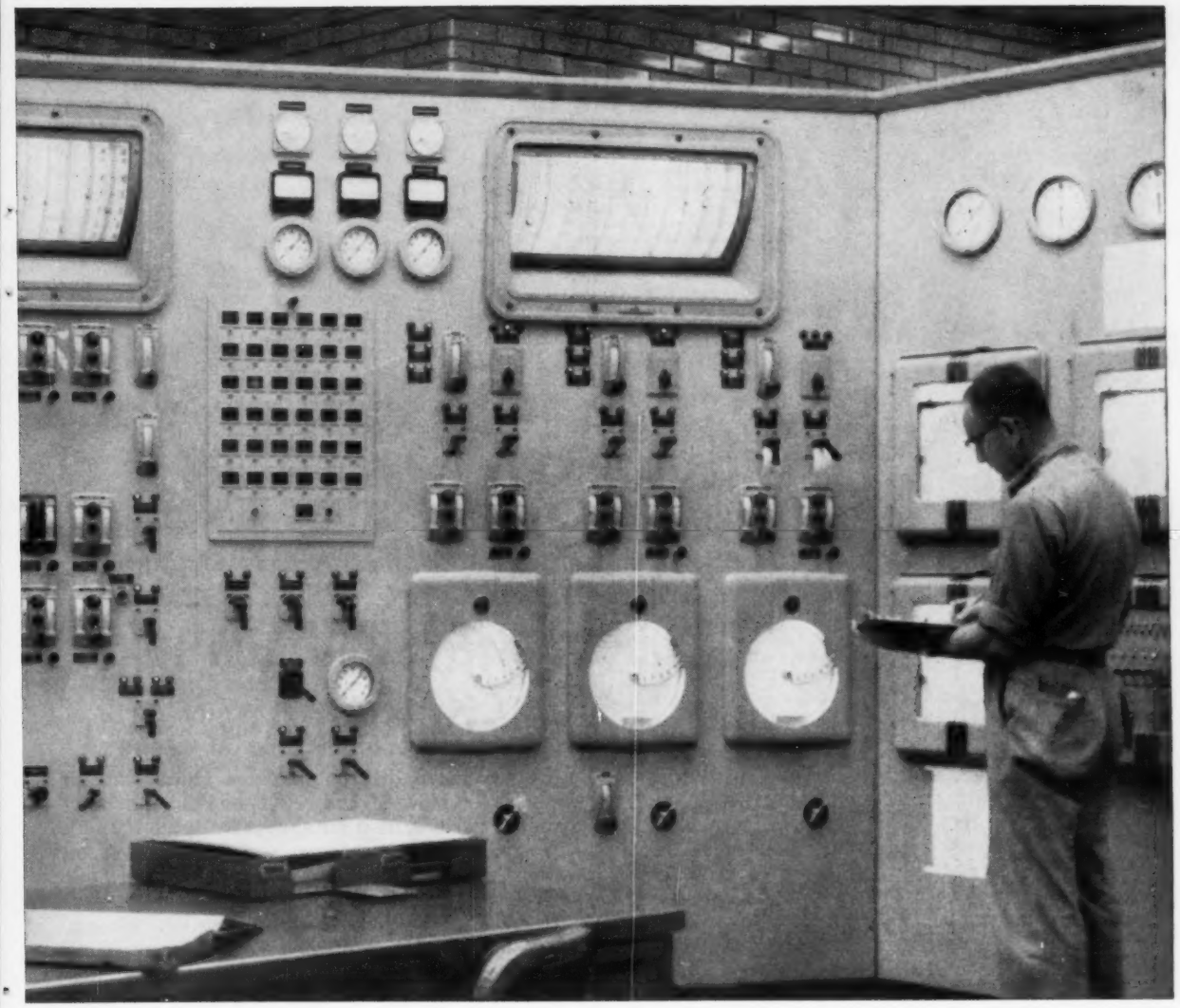
How it works

"*Once-through*" *steam generating units* must have radically different control systems from those used on drum-type boilers. At Philo, for instance, the Bailey Control for the 4500 psi, 1150F unit, maintains the desired rate of steam generation by means of a feed water flow controller which regulates feed-pump speed.

In normal operation this controller is set for a constant rate, and boiler outlet pressure is held to the desired value by automatic regulation of the turbine control valves.

An alternative operating method uses the turbine speed governor to regulate turbine control valves and varies feed water flow to maintain boiler outlet pressure.

With either method firing rate is varied to maintain final steam temperature. The Bailey System does this by regulating coal and air in parallel, primarily from changes in feed water flow with secondary adjustments, when necessary, from steam temperature.



SUPERCRITICAL STEAM PLANTS

Optimum combustion conditions are maintained by Bailey Oxygen-Combustibles Recorder-Controllers which continuously sample exit gases from each cyclone and automatically adjust coal feeder speeds.

Seasoned Engineering Experience

For greater fuel savings, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. And, for your convenience (and to save time and travel expense) there's a Bailey District Office or Resident Engineer in or close to your industrial community.

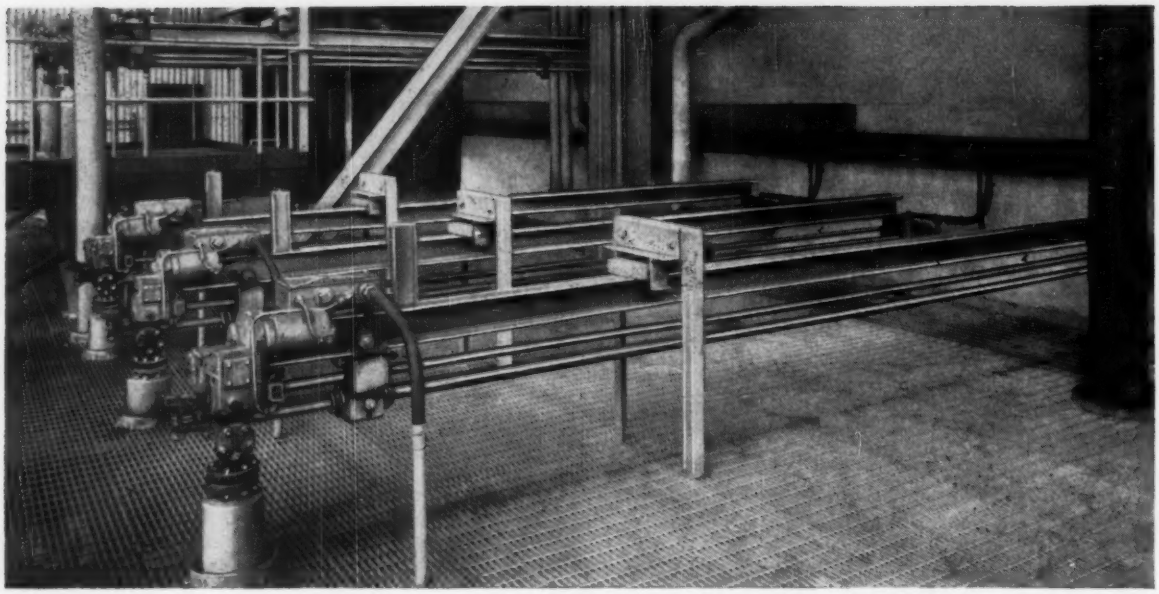
Arrange to visit a nearby Bailey installation. We stand on our record. A135-2

Instruments and controls for power and process

BAILEY METER COMPANY

1036 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal



Vulcan Automatic-Sequential System controls soot blowing at new Gannon Station

As the first modern utility boiler in Florida to be fired by coal, Tampa Electric Company's Gannon Station incorporates the most advanced control systems. Unit 1, with its boiler rating at 950,000 pounds per hour at 1760 psig and 1000 degrees F., uses a Vulcan soot blowing system that features both group and unit control.

Vulcan T-3-E long retractable soot blowers with their dual-motor drives clean Gannon's Unit 1 boiler with double-helix patterns for complete coverage. The system includes Vulcan wall deslaggers and rotary soot blowers—all driven by electric motors and using steam as the blowing medium. A Copes-Vulcan diaphragm valve reduces steam pressure for blowing and a Copes-Vulcan motor-operated valve is used for shut-off.

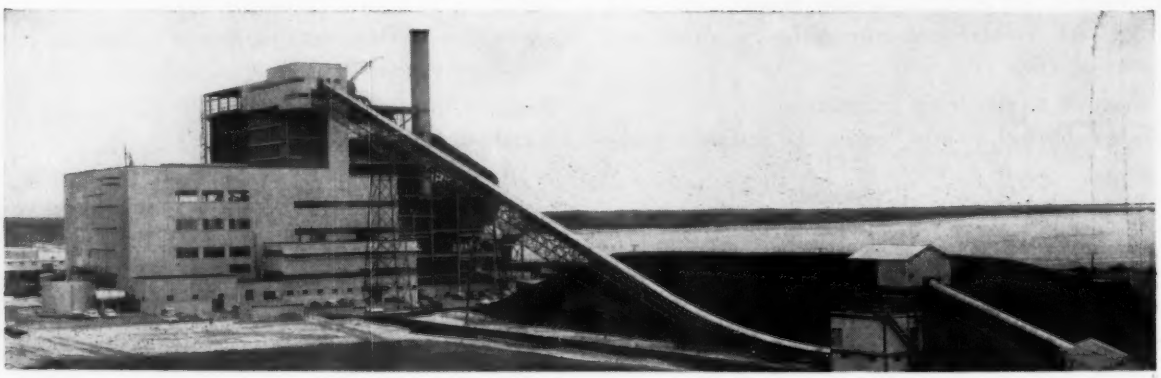
A similar Vulcan system will be installed on Gannon's Unit 2, rated at 950,000 pounds per hour at 1760 psig and 1000 degrees F.

Besides fully-automatic soot blowing systems, Copes-Vulcan offers complete systems for controlling combustion, feedwater, boiler feed pump recirculation, and steam temperature. Whether your boiler is large or small, power or process, Copes-Vulcan can provide a unit or an integrated package, custom designed to your requirements.

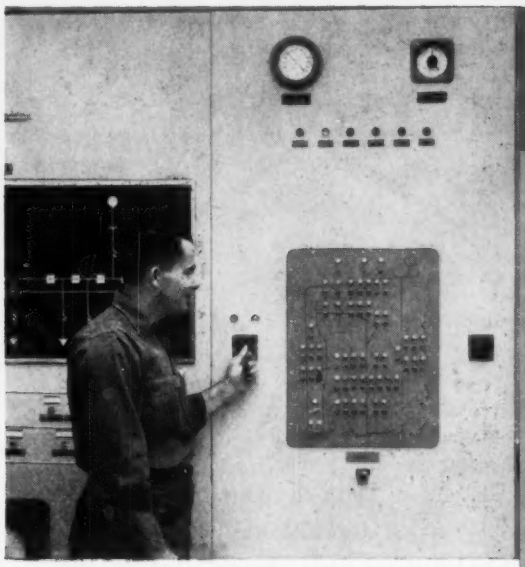
Copes-Vulcan Division

BLAW-KNOX COMPANY

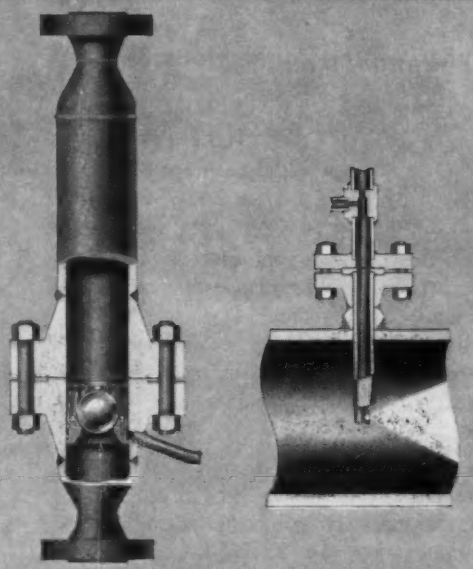
Erie 4, Pennsylvania



C-V NEWS NOTES



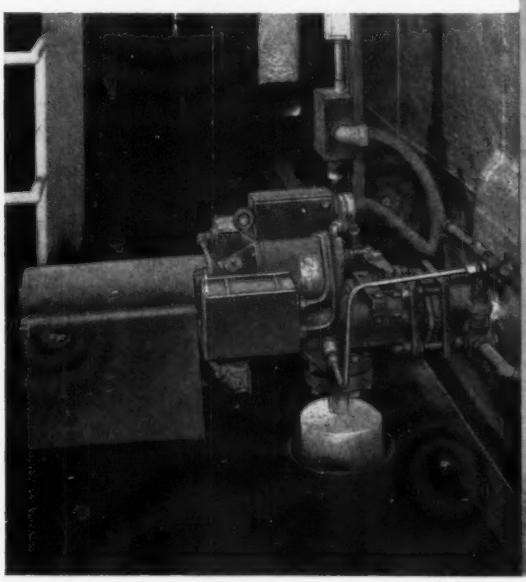
Finger tip control for Gannon's operators . . . with Vulcan's Automatic-Sequential group and unit control. Operator can preselect any number of soot blowers for automatic sequence . . . preselect any number of units or groups of units to be operated individually . . . or switch instantly to single unit operation. Program lights and toggle switches are located on engraved boiler diagram. Automatic-Sequential systems use steam, air or a combination as the blowing medium without a change in equipment. Write for Bulletin 1029.

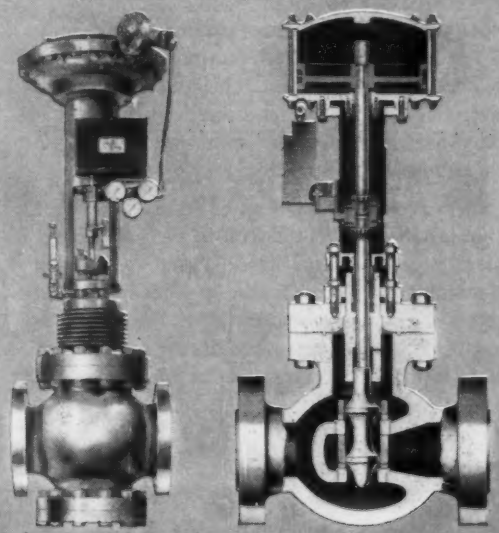


Desuperheaters improve temperature control. Variable-Orifice Desuperheater* (left) uses a weighted steel ball to control orifice opening . . . holds reduced steam temperature constant only twenty feet downstream from desuperheater outlet, even over a 50-to-1 load range. Bulletin 1037. *Patent Applied For

Steam-Assist (right) meets all specifications for conventional steam-atomizing type yet normally uses assisting steam only on light loads where control is most difficult. Mechanical-atomizing types also available. Bulletin 1024-A.

Wall deslagger conserves steam . . . minimizes average slag thickness. Vulcan's RW-3E is equipped with dual motors: one to traverse *fast* to get the nozzle to and from the blowing position almost instantly . . . the other to rotate the tube slowly for thorough cleaning. The RW-3E may be installed indoors or out, at almost any angle from side wall, roof or floor. It has only one outside stuffing box, no threads or working parts in the blowing medium to assure easy maintenance. Write for Bulletin 1034.





Versatile regulator valves offer new simplicity of design. Diaphragm-type CV-D (left) is designed for remote control service. It can be direct or reverse acting, has excellent rangeability. Piston-type CV-P (right) is designed for high-duty service . . . assures maximum power with precise positioning.

All Copes-Vulcan valves are tailored to the job. The style of valve port is selected to provide optimum control for specified operating conditions. Bulletin 1027.

GAS FIRED WATER HEATER | SUBMERGED COIL

JENKINS PRACTICAL PIPING LAYOUTS

82

How to plan piping connections for

A HOT WATER SUPPLY SYSTEM

using both Submerged Coil and Separate Water Heater

Continuous hot water for general use is a requirement of many small office buildings, taxpayers, stores, and sections of multi-story buildings. In this layout, two conventional methods of supplying hot water are shown in combination, assuring continuous supply throughout the year with a minimum investment and maximum convenience.

A submerged coil utilizes as a heat source the main boiler whose primary function is to furnish heat for the building. A separately fired heater is employed to provide continuous hot water should the operation of the main boiler during the non-heating season prove uneconomical, or should normal maintenance requirements result in a shutdown of the main boiler. Connections to both units of hot water generating equipment are arranged so that change-over involves only the operation of valves. The distribution system shown incorporates a circulating pump and return loop, to guarantee hot water at the fixtures at all times.

A Blender valve with the submerged coil permits tempering water to the desired temperature, and is equipped with by-passes to permit blender maintenance and emergency repairs without a shutdown. The separately fired heater has its own thermostatic control, so does not require a blender valve.

Safety valves protect both hot water generators. These valves are installed without shutoff to prevent damage and especially damage from possible steam generation in the separately fired heater. Also, it is recommended that cold water admission valve "E" to this heater be left open at all times, except when draining the heater, to prevent formation of a vacuum or burning of the heater if evaporated dry.

Bronze valves are used throughout because they give best service with most conditions of city water. All gate valves shown are of the traveling spindle type, which indicate at a glance the position of the wedge.

Jenkins Fig. 106-A screwed end bronze globe valve, (or its equivalent Fig. 1270 with socket ends, or Fig. 1270 with solder ends), is used extensively throughout this piping layout. Its renewable composition disc assures drop-tight closure, and it incorporates many other design and construction features which mean economical maintenance and long, trouble-free life.

To assure efficiency in the job when planning any major piping installation, consult with accredited piping engineers and contractors.

To make certain of trouble-free, economical valve performance, select your valves from the Jenkins Catalog. It shows types and patterns, made of different metals for an endless variety of needs.

For prompt, capable help when you want Jenkins Valves and other supplies for your job, call the top-flight distributor who represents Jenkins in your city.

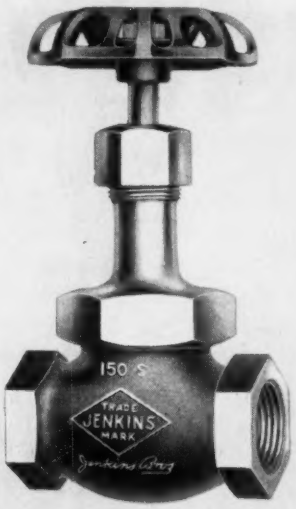


Fig. 106-A BRONZE GLOBE VALVE Renewable Composition Disc
150 lbs. Steam 300 lbs. O.W.G.

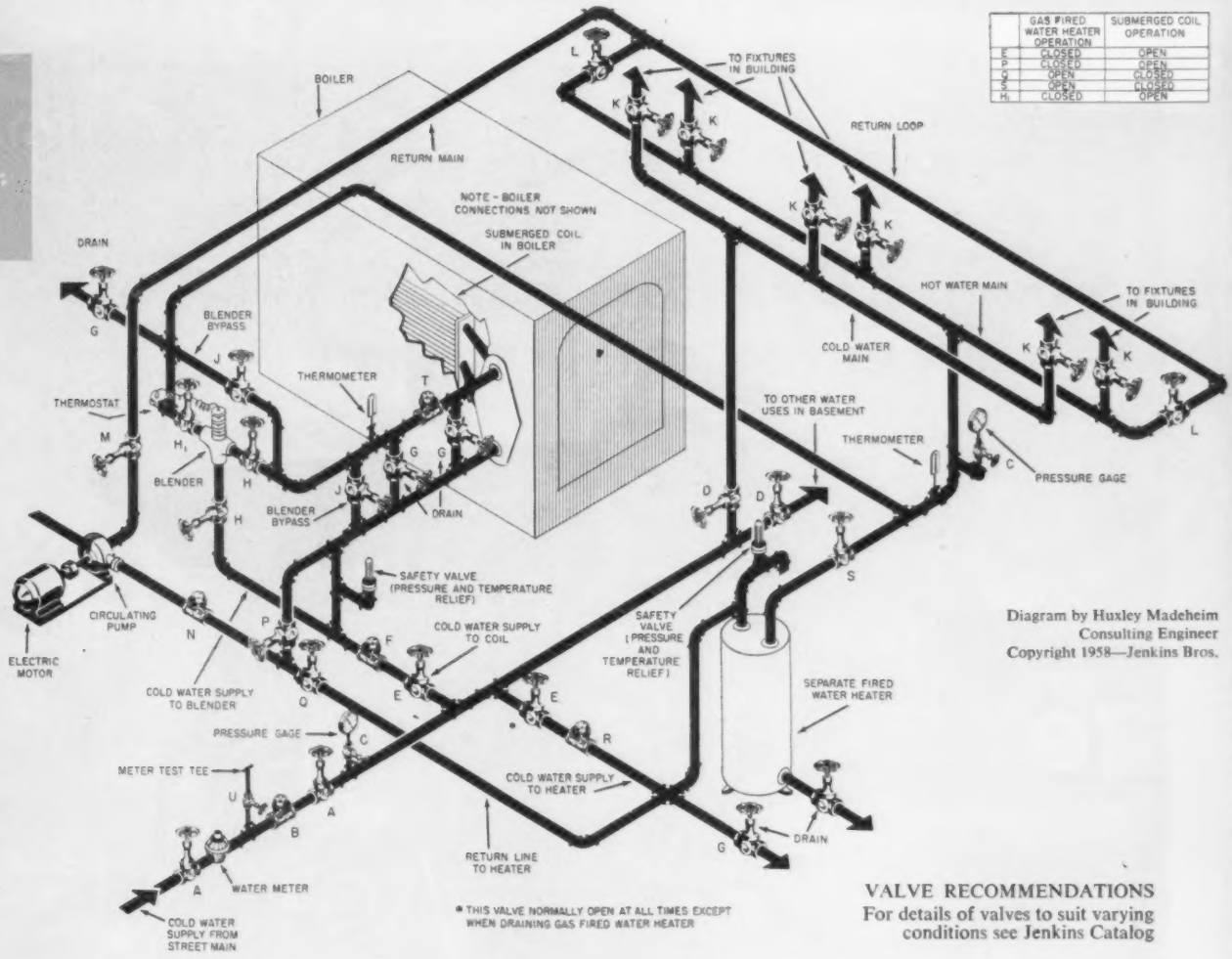
JENKINS BROS.
100 Park Avenue, New York 17

Send descriptive folder 189-A on Fig. 106-A Bronze Globe Valves.

Name.....

Company.....

Address.....



	GAS FIRED WATER HEATER OPERATION	SUBMERGED COIL OPERATION
E	CLOSED	OPEN
P	CLOSED	OPEN
Q	OPEN	CLOSED
S	OPEN	CLOSED
H_1	CLOSED	OPEN

Diagram by Huxley Madeheim
Consulting Engineer
Copyright 1958—Jenkins Bros.

VALVE RECOMMENDATIONS

For details of valves to suit varying conditions see Jenkins Catalog

TABLE OF RECOMMENDED JENKINS VALVES

Code	Quantity	Screwed	Socket	Solder	Type	Service
A	2	Fig. 47-U	1273	1242	Gate	Shutoff Cold Water Supply
B	1	" 92-A	1272	1222	Check	Prevent Backflow to Main
C	2	" 743-G			Needle	Control Pressure Gage
D	2	" 47-U	1273	1242	Gate	Shutoff Cold Water Dist. System
E	2	" 106-A	1270	1200	Globe	Control Cold Water Supply to Heaters
F	1	" 92-A	1272	1222	Check	Prevent Backflow from Coil to Main
G	5	" 106-A	1270	1200	Globe	Control Drains
H	3	" 47-U	1273	1242	Gate	Shutoff Blender
J	2	" 106-A	1270	1200	Globe	Control By-pass about Blender
K	6*	" 106-A	1270	1200	Globe	Control Water Supply to Individual Fixtures
L	2	" 106-A	1270	1200	Globe	Control Flow through Return Loop
M	1	" 47-U	1273	1242	Gate	Shutoff Suction Circulating Pump
N	1	" 92-A	1272	1222	Check	Prevent Backflow through Circulating Pump
P	1	" 106-A	1270	1200	Globe	Control Flow Return Water to Coil
Q	1	" 106-A	1270	1200	Globe	Control Flow Return Water to Heater
R	1	" 92-A	1272	1222	Check	Prevent Backflow from Heater to Main
S	1	" 47-U	1273	1242	Gate	Shutoff Hot Water Supply from Heater
T	1	" 92-A	1272	1222	Check	Prevent Backflow through Coil
U	1	" 106-A	1270	1200	Globe	Control Meter Test Line

*Dependent on quantity of fixtures.

Sold Through Leading Distributors Everywhere

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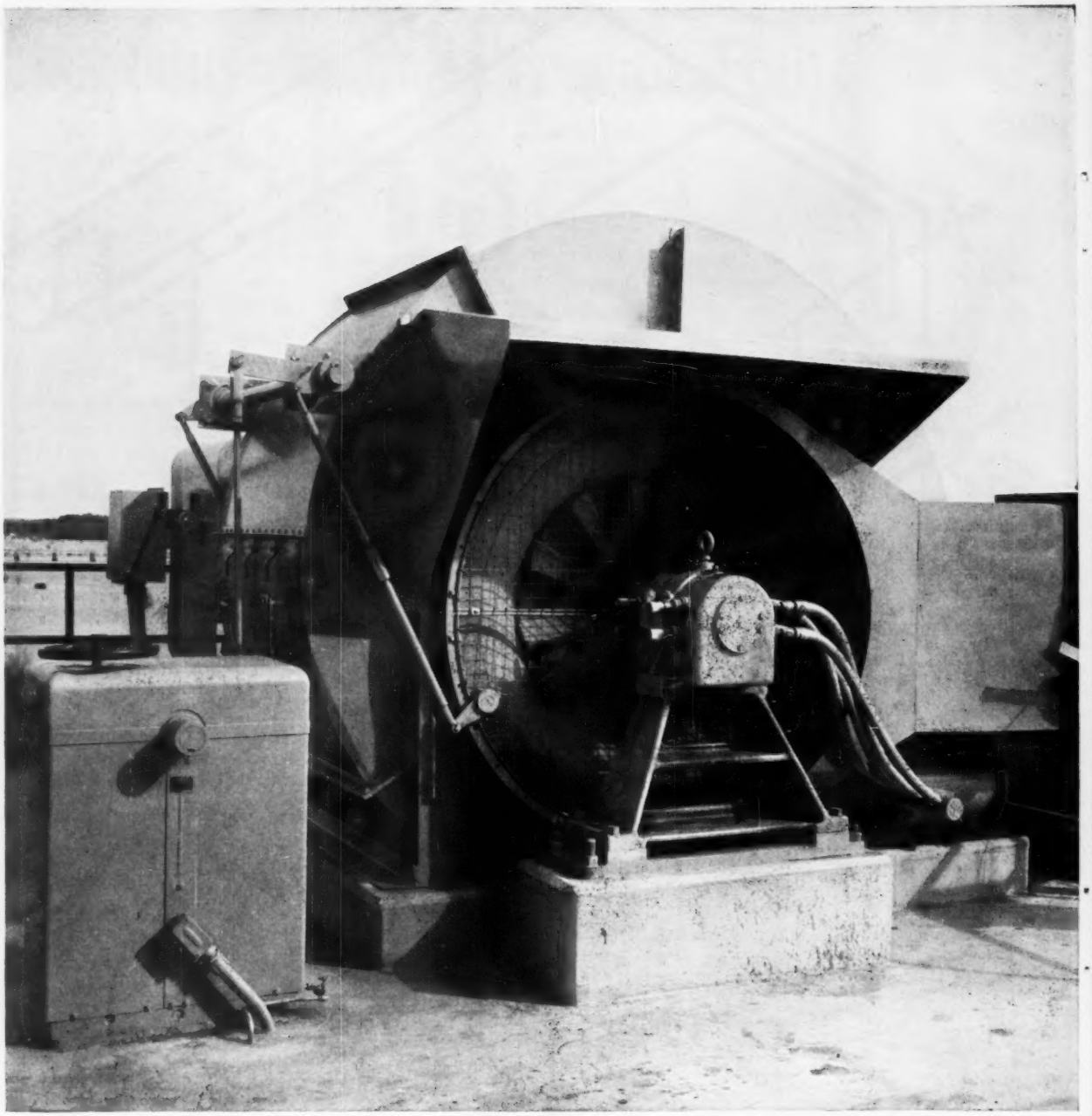
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS
SINCE 1864
Jenkins Bros



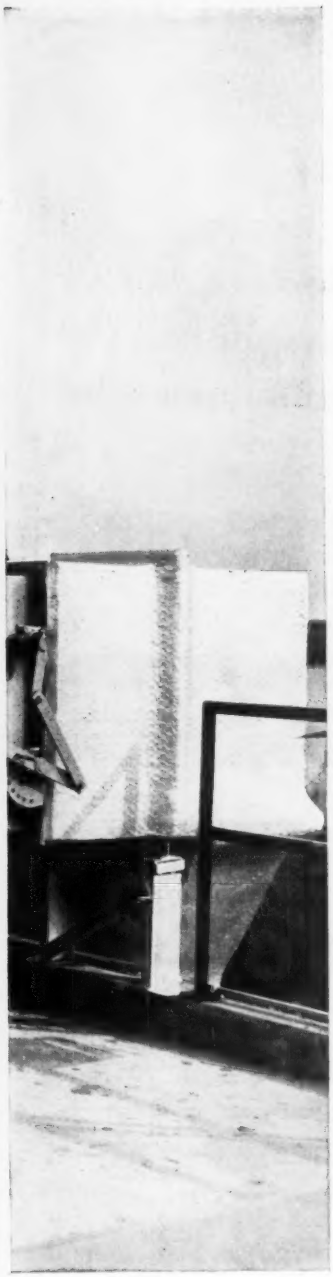
A Typical "Buffalo" Outdoor Forced Draft Installation.

"Buffalo" Mechanical Draft Fans are available with Forward Curved, Radial, Backward Curved and Airfoil Bladed Wheels.

BUFFALO FORGE COMPANY,

Buffalo Pumps Division
Canadian Blower & Forge

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT



HERE'S MECHANICAL DRAFT PERFORMANCE OUT IN THE OPEN

Here is a typical "Buffalo" Forced Draft Fan engineered for outdoor service. Features "A" apply primarily to outdoor installations. Features "B" apply to Buffalo Forced Draft Fans in general.

FEATURES "A": Note first the air cooled bearing mounted on rigid cast iron pedestals and soleplates. Pressure from fan discharge provides air for cooling. Air passes through automotive type filter before entering oversize cooling passages and specially designed bearing sleeves. Use of air cooled bearings removes danger of freezing.

SHIELD OVER INLET helps keep rain and snow from fan air stream. SCREEN keeps loose objects from entering.

RECIRCULATING AIR DUCT brings preheated air to fan inlet for mixing with outside air to prevent corrosion in air heater at low boiler loads.

PROPORTIONING DAMPERS in this duct regulate and mix the air flow.

FEATURES "B": HEAVY DUTY VARIABLE INLET VANES deeply positioned in inlet for maximum horsepower reduction at reduced loads. Vanes are cantilevered, nothing obstructs inlet air flow. One lever accurately controls dampered combustion.

INSPECTION DOOR has quick opening latches for easy access to fan housing.

OVERALL "Q" FACTOR CONSTRUCTION is strictly heavy duty. Steel plate and rigid bracing contribute to maintenance-free fan life.

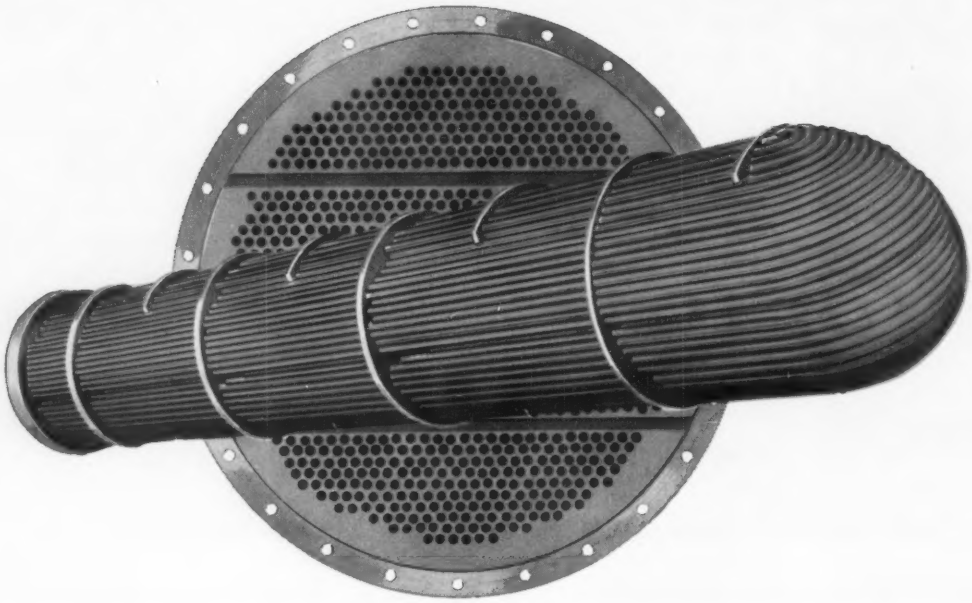
BUFFALO, NEW YORK
Buffalo, N. Y.
Co., Ltd., Kitchener, Ont.

"Buffalo"

EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

Specify

DUAL-GAUGE



First for Lasting Quality—from Mine to Market!

To keep tubes uniformly strong
in condensers, feed water heaters,
heat exchangers and similar equipment . . .

PHELPS DODGE

TUBING!

- Provides heavier wall thickness:
  - **a.** At one or more points in tube length to compensate for thinning on outer portions of return bends.
  - **b.** At points of support.
  - **c.** At tube ends to meet special requirements.
- Produced in all standard sizes or manufactured to the particular design requirements of individual customers.
- Available in Cupro-Nickel, Red Brass, Aluminum Brass, Admiralty metal and Muntz metal.

PHELPS DODGE COPPER PRODUCTS CORPORATION
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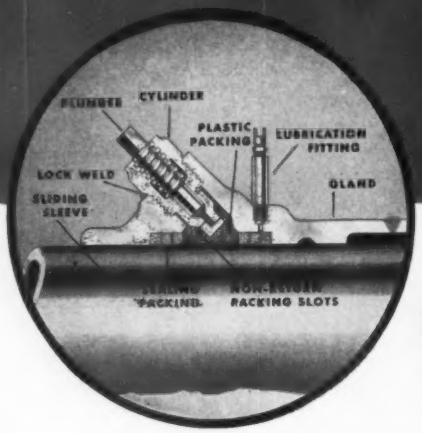
new savings

for expansion joint users...

YARWAY TYPE W GUN-PAKT

20" Yarway Type W Gun-Pakt Joint with base, single type, welding ends, 8 guns.



Cross-section of Gun-Pakt feature. To add packing, just add a plug and turn the plunger. Note non-return packing slots at bottom of cylinder.

YARWAY® GUN-PAKT

The Yarway Type W Gun-Pakt Expansion Joint has an improved one-piece design of body and gland and improved method of packing that provide new maintenance economies and greater operating efficiency.

Bolted joint between body and gland is eliminated; the steel body includes gland and guide. Shorter face-to-face dimensions are possible. Improved angle of packing guns makes them more accessible and *permits injection of the special plastic packing directly into packing space.*

The famous Yarway *Gun-Pakt* feature permits *addition of packing under full steam pressure. No need for costly shutdowns to repack.*

Sizes 1½" to 30", pressures 150, 300, 400 psi. Single or double types, flanged or welding ends.

For full description, write for new Yarway Bulletin EJ-1916.

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BRANCH OFFICES IN PRINCIPAL CITIES

TYPICAL GUN-PAKT EXPANSION JOINT USERS

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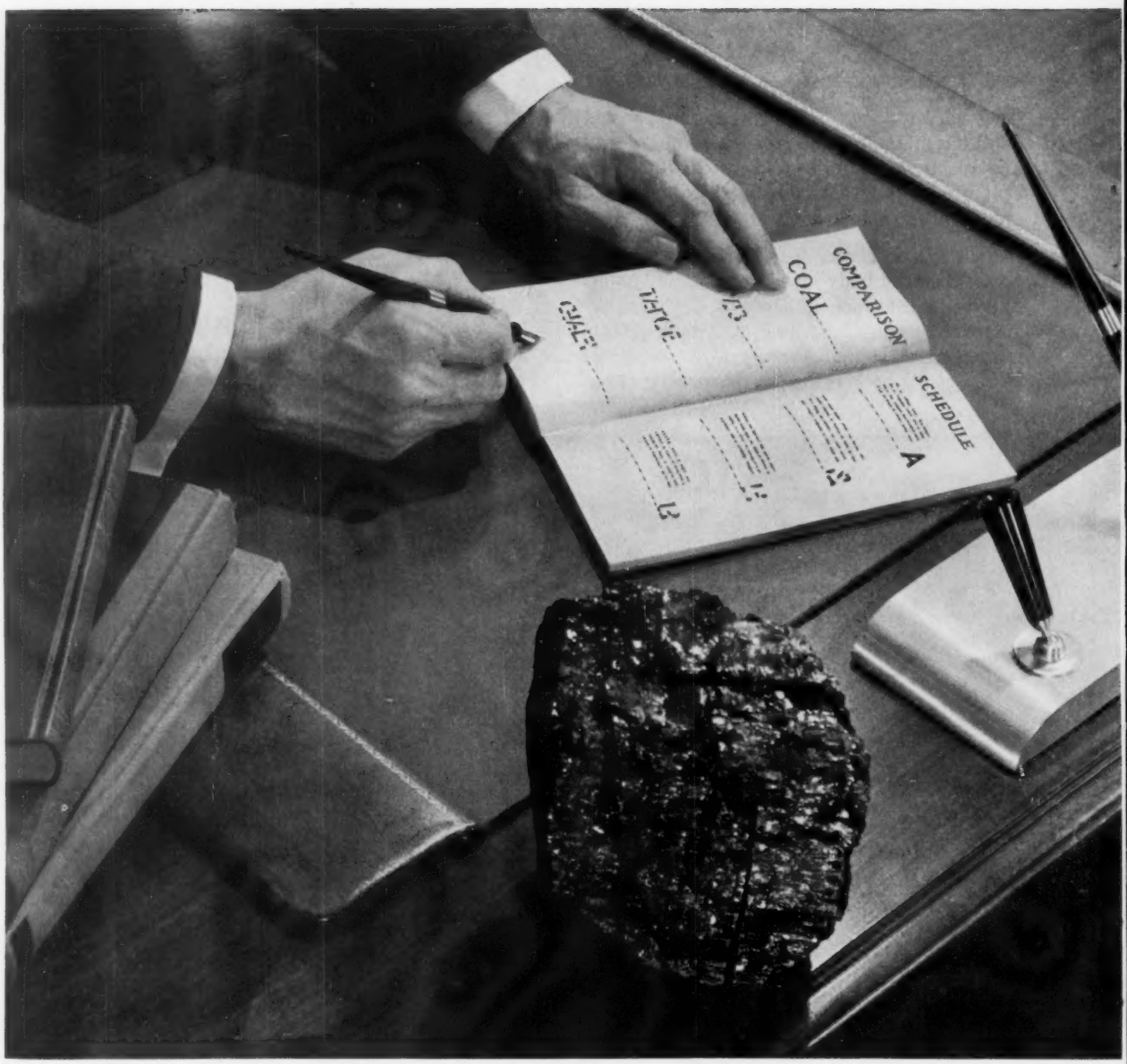
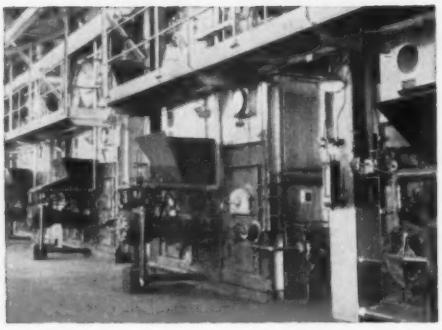
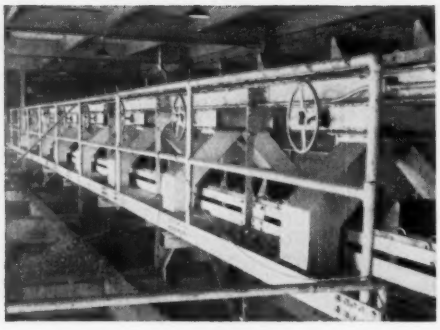
...a good way to specify expansion joints

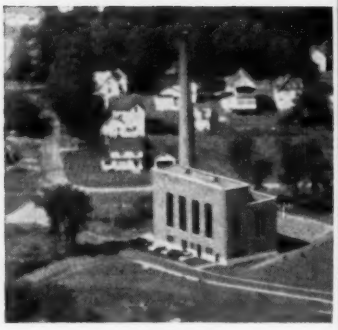




View of boiler room at State University. Boilers are 300 hp units, made by E. Keeler Co., and fired by Flynn and Emrich Single Retort Stokers. Average steam load currently is 9,000 lb/hr, requiring only one boiler most of the time.



The SY-CO Corp. V-bucket conveyor-elevator and 250-ton coal bunker storage area. Coal is delivered by truck to hopper, then moves by elevator to bunker. By the use of gates, coal may be channeled to any part of bunker.



This attractive power plant combines modern design with capacity sufficient to allow for expansion of campus facilities.

Coal gets high mark for low cost

Coal at Teachers College costs 1/3 LESS than competitive fuel

When State University Teachers College moved to its new campus in Potsdam, N. Y., the Department of Public Works had the job of planning the college's heating and steam facilities. The fuel chosen was coal . . . and today coal is burned throughout the academic year in modern equipment for efficient, automatic performance. The outstanding feature of this plant has proved to be coal's low cost—⅓ *less* per million Btu than competitive fuel in this area!

Coal is lowest-cost fuel

Today comparison studies prove that bituminous coal is the lowest-cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% *more* steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

Technical advisory service

To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below or send coupon. Ask also for booklet on case histories, complete with data sheets. You'll find them informative.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you in the efficiency and economy of coal.

BITUMINOUS COAL INSTITUTE

Dept. P-11, Southern Building, Washington 5, D. C.

Hays Automatic Combustion Control Panel regulates boiler operation . . . contributes to overall "ease of operation" and minimum labor.

SEND COUPON FOR *NEW* "Guide Specifications for Underfeed Stoker Fired Low-Pressure Heating Plants." Heavy demand for the first edition of this booklet, adaptable for design loads 3,000 to 26,000 EDR steam, has justified an expanded edition covering application of underfeed stokers to firetube, watertube and sectional cast iron boilers. Complete specifications criteria cover all aspects of typical heating plant.

Bituminous Coal Institute, Southern Building, Washington 5, D. C. P-11

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☐ Guide Specifications Booklet ☐ Case histories on larger plants

☐ I am interested in your advisory service

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City_____ Zone_____ State_____

THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments

Manual or automatic

Wheelco Flame-otrols

for flame-failure protection

Features of the Wheelco super-duty automatic Flame-otrols are visible at a glance in this special display installation. Note ready accessibility of principal components.

Automatic Operation

Sequence timing for oil- or gas-fired burner or boiler application includes: purging, warm-up proving, pilot proving, low-fire stabilization, ignition timing, and post purging. Terminal connections for directly handling a flame-failure alarm and a proportioning-type control motor are also included. Model 1474 uses flame-rods and emissive-type photo cells as sensing elements, while Model 1574 uses lead-sulphide cells as sensing units.

Manual Starting

Once the oil- or gas-fired furnace, oven, etc. is started, the Flame-otrol shown here takes over the problem of flame supervision. After fuel ignition, the manual model provides for complete burner shutdown protection immediately following flame outage or high-limit "off" switching. Flexible circuit design makes possible use of various auxiliary equipment such as push-button starting, external timers for purging or timed ignition trial. Both "CR" systems using flame-rods and "IR" systems using lead-sulphide sensing cells are available.

Addition of super-duty automatic models for package boiler installations rounds out complete line of combustion safeguards for gas, oil, or combination burners.

Whatever the combustion safeguard requirements on furnaces, boilers, kilns, dryers, and similar applications — there's a Wheelco Flame-otrol to provide superior performance and unmatched dependability. The same sure operation and simplified maintenance that has characterized the manually or semi-automatically started models is designed into the new super-duty Flame-otrols for package boiler operations.

TWO BASIC SYSTEMS

Basically, there are two control systems available for Flame-otrol operations: Conductivity-Rectification "CR" system and Infra-Red "IR" system. A lead-sulphide cell is used as a sensing element in the "IR" system; flame-rods and emissive-type photo cells are sensing elements in the "CR" system.

Both flame "pick-up" methods are available in automatic or manually started models. Compact, plug-in design is incorporated in all models, offers maximum accessibility for adjustment, examination, and repair. The chassis are held in position for normal operation by captive latches or a retaining screw with the exclusive Wheelco terminal strip guaranteeing uniform contact pressure while permitting easy removal.

SIMPLIFIED MAINTENANCE

Convenient checking strips simplify trouble-shooting and normal maintenance — require only the use of standard instruments for checking circuits and voltages. Because standard electronic tubes are used throughout, inventory requirements of spare parts are reduced appreciably. Replacements can be obtained readily at any electronic supply house.

Heavy-duty construction of Wheelco Flame-otrol cabinets is an important factor in long, trouble-free operation of the units in all types of plant locations. The rugged, industrial-type steel cabinet with gasketed, dust-tight swing-out cover keeps out foreign matter that might interfere with operating efficiency. Applications requiring a flush-mounted unit are furnished with a cabinet that includes the necessary mounting flange.

Write for literature describing operations of either manual or automatic Flame-otrols today or, better still, have a Wheelco field engineer analyze your combustion safeguard needs. There's no obligation and you can be sure this analysis will be thorough with the recommendations specifically directed to the solution of your problems.

Control Centers

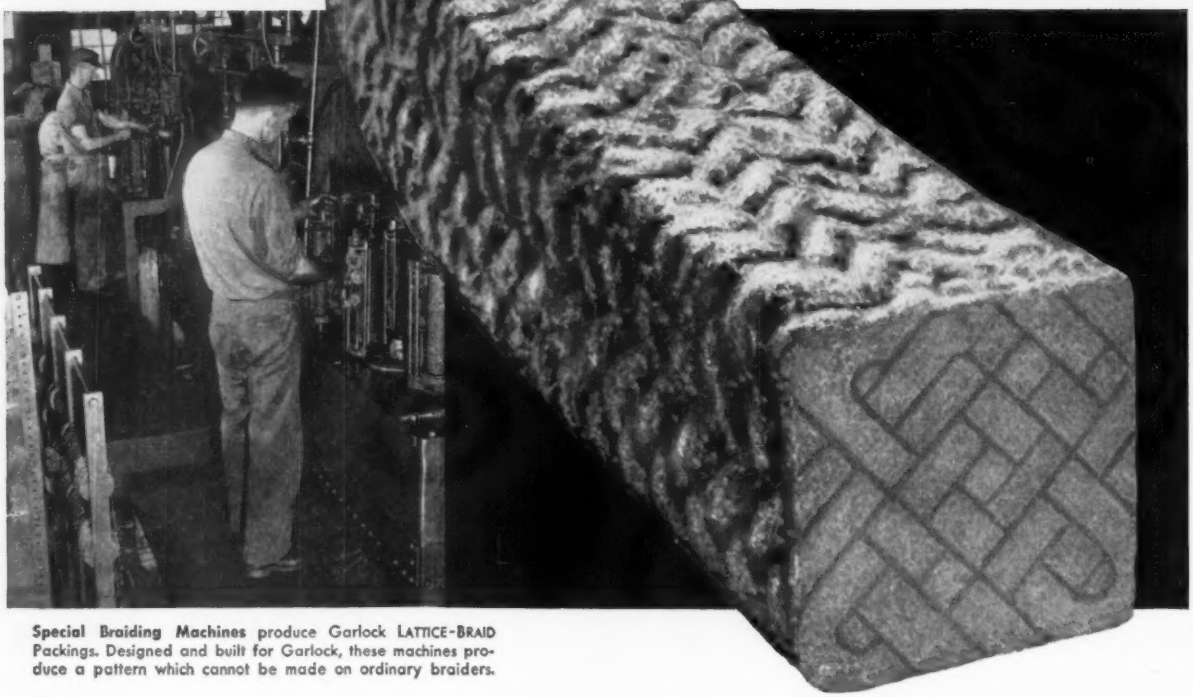
Where a method of housing a complete combustion safeguard system, including Flame-otrols, pilot lights, alarms, etc., is required or desirable, prewired Wheelco control centers reduce installation costs and time, plus providing an attractive centralized package. Flexibility to meet changing requirements is provided by use of removable sections. Bolt-down or hinged covers permit convenient servicing or system checking.

BARBER-COLMAN COMPANY

Dept. J, 1551 Rock Street, Rockford, Illinois, U. S. A.
BARBER-COLMAN OF CANADA, Ltd., Dept. J, Toronto and Montreal, Canada

MORE OF THE GARLOCK 2,000

HOW GARLOCK



Special Braiding Machines produce Garlock LATTICE-BRAID Packings. Designed and built for Garlock, these machines produce a pattern which cannot be made on ordinary braiders.

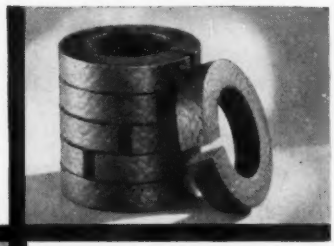
Users Report:

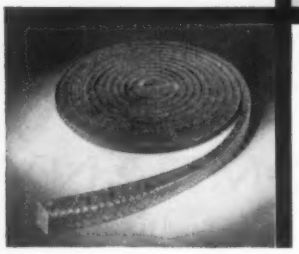
Chemical Industry

Centrifugal dye pumps required repacking every 24 to 48 hours. Changed to LATTICE BRAID asbestos packing with Teflon impregnation. Results: minimum of 3 month's service.

Food Industry

LATTICE-BRAID blue asbestos packing, Garlock 5880 in constant use 24 hours a day on centrifugal prune pulp pump and still in service after 8 months.





Metalworking Industry

LATTICE-BRAID flax outlasts ordinary braided flax three to four times on accumulators, hydraulic rams, lifts, etc. . . . does not break up and rams show less wear.

Oil Industry

Centrifugal transfer pump alternately handling caustics, lime, acid and solvents at temperatures to 200° F. was repacked twice a week . . . shaft replaced twice a year. LATTICE-BRAID has given 10 months continuous service . . . saving over $100. already in materials alone.

LATTICE-BRAID* PACKINGS DIFFER

from Ordinary Braided Packing

The Garlock LATTICE-BRAID Packing is distinctly different . . . the result of many years of development and experimental work.

Special machines are required to manufacture the LATTICE-BRAID structure. And the superiority of LATTICE-BRAID packings is due to the unique braiding pattern which cannot be duplicated on ordinary braiding machines.

ADVANTAGES: unified structure gives greater strength; no disintegration; less gland adjustment; unusual flexibility.

**Registered Trade Mark*

Garlock LATTICE-BRAID. Every strand passes diagonally through body of packing at approximately 45° angle producing completely unified structure. Every strand contributes to strength of entire mass.

Ordinary square braid. Each strand merely passes over and under other strands. No strand passes entirely through packing. No common linkage . . . no unified structure, less strength.

Ordinary round braid packing is built-up to size by braiding one or more covers over a solid core. No unified structure—when outside covers wear through, packing is no longer serviceable.

LATTICE-BRAID is another important part of "the Garlock 2,000"...two thousand different styles of packings, gaskets, and seals to meet all your needs—the *only* complete line. That's why you get *unbiased* recommendations from your Garlock representative. Call him today or write for LATTICE-BRAID Folder AD-131.

THE GARLOCK PACKING COMPANY, Palmyra, New York

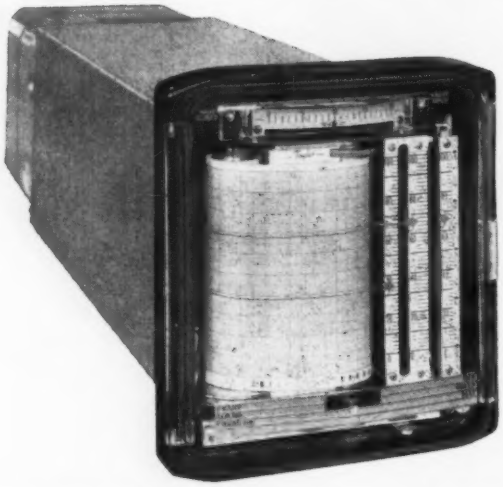
For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

New Taylor TRANSCOPE Recorder brings you*

REVOLUTIONARY ACCURACY AND BIG-INSTRUMENT FEATURES



"No other recorder, regardless of size, puts so many features in so little panel space."

Front of Panel Control Settings let you make adjustments easier, quicker, and better . . . *from the front of the panel* . . . while recording! You can clearly see what you are doing, and the results, because the record is continuous.

Stays on Automatic Control while the recorder is removed for inspection. The unique Set Point Transmitter remains plugged in the case, providing continuous fully automatic control.

Complete Indicating Control Station while recorder is removed. You see the variable. There's no need to shut down the process for instrument service or adjustments. Horizontal gage at top of recorder will show either process variable or air output to valve, as desired.

Receives Three Variables to be recorded or indicated; has a Set Point Transmitter, an Automatic-to-Manual switching lever, a Cascade or process-output indicator, and many other features . . . all in a compact case.

"SERVOMATIC" Motor assures lifetime accuracy of pen position. Transmitter signal is received and amplified by individual force-balance servomechanisms. Spring feedback and powerful pneumatic motor give 150 times greater power than normally available for pen positioning.

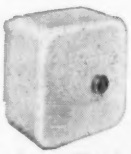
0.1% Threshold Sensitivity—a new standard of accuracy. Responsiveness to transmitter output is 0.1%, and because of the very small pneumatic displacement of the input capsule, is practically instantaneous.

Optional Alarms. Each SERVOMATIC motor can operate either an electric or pneumatic alarm. Each alarm can be adjusted for one high and one low, or two high or two low operating points.

For further information about this revolutionary new recorder, see your Taylor Field Engineer, or write for **Catalog 98286.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ontario.

*Trade-Mark

MADE FOR EACH OTHER!



The Taylor TRANSCOPE Controller and Recorder are companion instruments. Together they give you new standards of process control performance . . unprecedented accuracy and adaptability.

Ideal for the time constants of modern processing, exceptionally fast and responsive to adjustments, the TRANSCOPE Controller is also highly adaptable and simple to maintain. Write for **Bulletin 98278.**

Taylor Instruments

MEAN

ACCURACY FIRST

VISION • INGENUITY • DEPENDABILITY

to move an ocean–

by the bucketful is all right for this Sunday engineer, but for full time, 24-hour transfer of millions of gallons of water, rugged Peerless Hydro-Foil Pumps are the answer. Steam generation plants, sewage disposal plants, large irrigation and drainage projects, flood control stations and many other rigorous duties are being handled efficiently, dependably and economically by these giants of the pumping world. Available as either propeller type or mixed flow type, Peerless Hydro-Foil pumps have proved themselves to be the finest from every standpoint. For the big jobs, get the big pump, get the Peerless Hydro-Foil!

WRITE FOR ILLUSTRATED BULLETIN NO. B-148

PEERLESS PUMPS

Putting Ideas to Work

fmc FOOD MACHINERY AND CHEMICAL CORPORATION ®

FOOD MACHINERY AND CHEMICAL CORPORATION

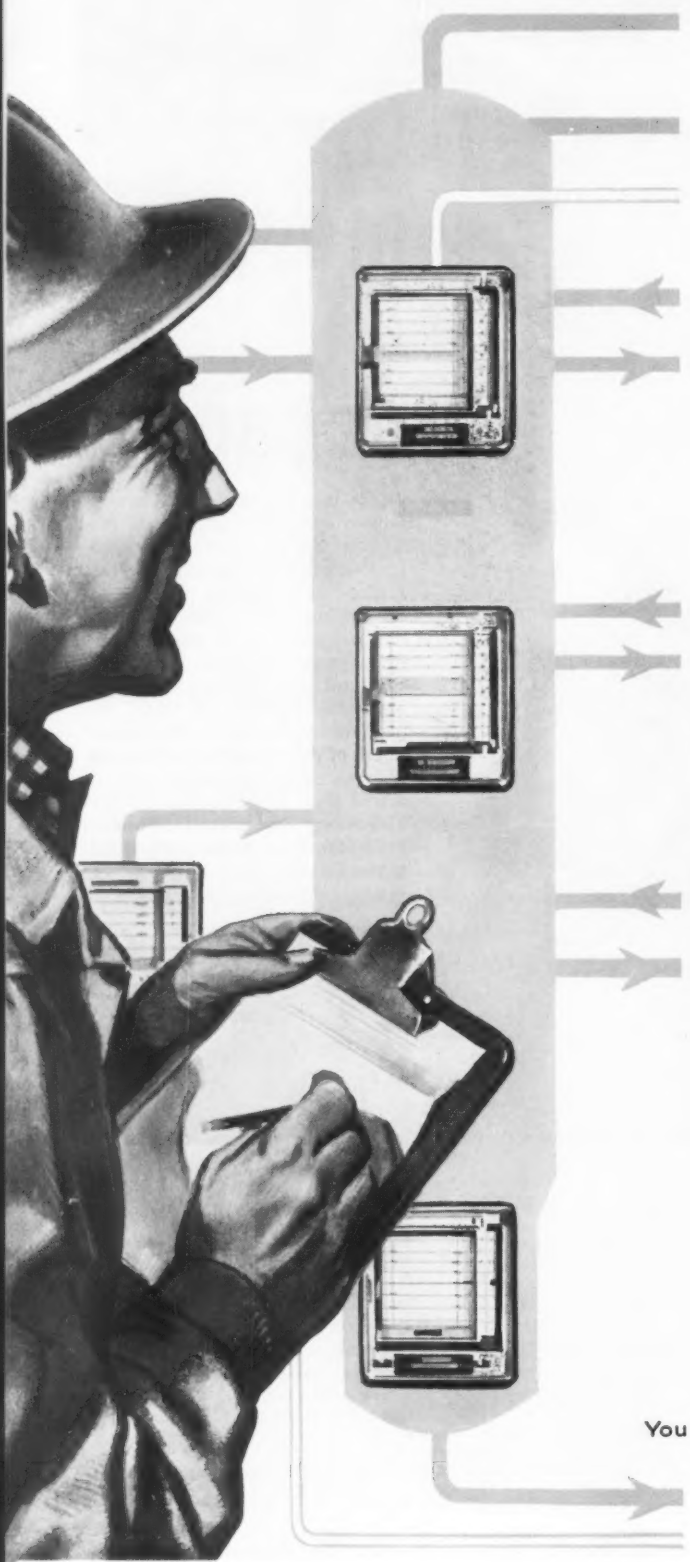
Peerless Pump Division

Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA

Offices: New York; Atlanta; St. Louis; Phoenix; San Francisco; Chicago; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque. **Distributors in Principal Cities.** Consult your telephone directory.

Nothing gets by

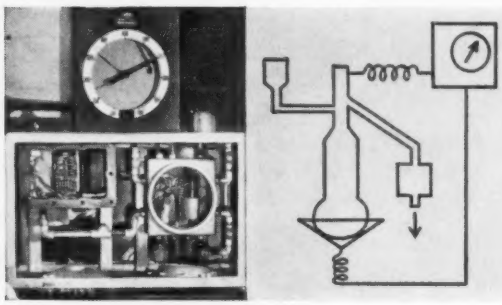
Automatic end-point testing device developed by Standard Oil research men makes certain of the uniform quality of gasoline and diesel fuel delivered to you.



Scientists at Standard Oil never stop in their drive to improve and then improve again the uniform quality of the petroleum products that bear the Standard Oil trade-mark. These engineering research scientists have now created wholly new instruments for performing near continuous physical analysis *automatically.*

One such instrument automatically performs the physical analysis that determines end-point. Using it, refineries maintain a continuous inspection of the temperature at which diesel fuels are completely distilled. To you, this means that Standard is able to maintain a constant control over the uniformity and high quality of the fuels you use to power your diesel engines. It also means that Standard Oil power-producing petroleum products, with their constantly controlled end-point, burn uniformly, give you uniform high performance.

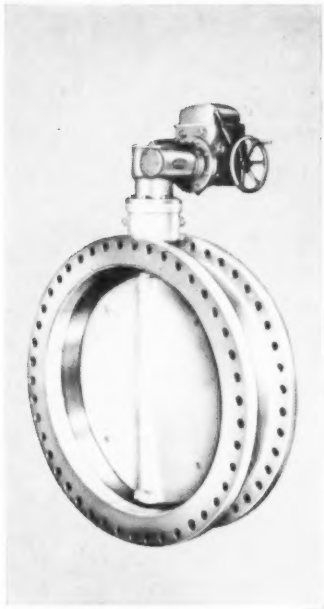
This is part of the research pay-out, the "something more" research builds into the products you buy from Standard. This is your return from Standard's investment in research. And now there are 48 district offices in the 15 Midwest and Rocky Mountain states to serve you. Call the one nearest you. **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**



Automatic end-point tester works this way. A small sample is placed in an electrically heated flask. The temperature is measured and recorded during a heating cycle when distillation is accomplished. Distillate is condensed and drained, the flask temperature is lowered by introduction of the next sample, and the apparatus is ready for another test.

You expect more from STANDARD and get it!

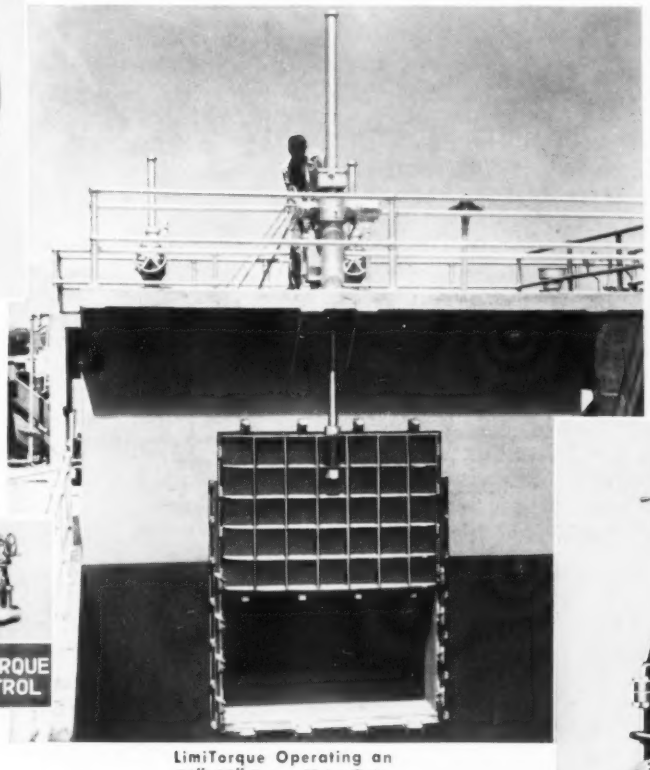
THERE IS NO SUBSTITUTE FOR LimiTorque



Type SMA LimiTorque operating a Henry Pratt Company 48" Butterfly Valve.

Yes! there is no substitute for LimiTorque. More engineers are recognizing this daily. A recent specification, from which we quote, "The motor operated valve shall be of the Philadelphia 'LimiTorque' type or full equal. Because this type has been proven in service similar to that for which this valve will be used and because of unsatisfactory results with other operators" . . . recognized the superiority of LimiTorque Valve Controls.

Why don't you specify LimiTorque?

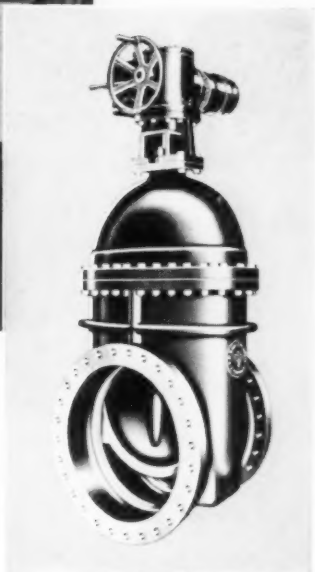


LimiTorque Operating an 84"x60" Armco Sluice Gate.

See us at Booth 141 Power Show Dec. 1st to 5th

For the full story on LimiTorque's time and money-saving features, write for Complete Catalog #L-550.

LIMITORQUE CONTROL



Type SMA LimiTorque operating a 30" A. P. Smith Co. Gate Valve.

LimiTorque has acceptance around the world being used widely in most every industry such as, Power, Chemical, Petroleum, Petro-Chemical, Pipelines, Water, Sewage, Marine, Aircraft and Missile. LimiTorque can be depended upon to operate your valves under the most adverse climatic or operational difficulties.

LimiTorque Controls can be field mounted on existing valves—contact your valve manufacturer, or our nearest sales engineering office.

LimiTorque®

PHILADELPHIA GEAR CORPORATION

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

Research-Cottrell

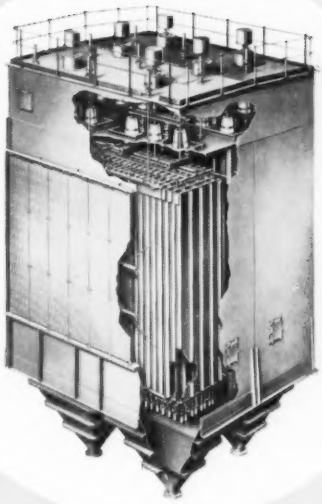
makes all three

3

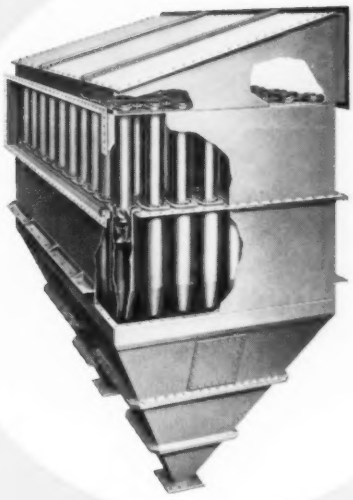
All three Research-Cottrell dust collectors are engineered for specific fly ash applications. Research's experience as the world's largest manufacturer of precipitators is well known. Over 600 straight and combination fly ash precipitators have been installed throughout the United States and Canada. • Research's Cyclo-trell, available since 1956, has already set new standards of efficiency for mechanical dust collectors. • For more information on Research-Cottrell's line of engineered dust collecting equipment, write for Bulletin PC.

Research-Cottrell

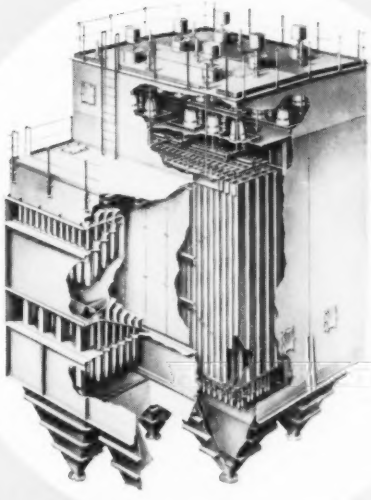
RESEARCH-COTTRELL, INC. Main Office and Plant: Bound Brook, N. J. • 405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa. • 228 N. La Salle St., Chicago 1, Ill. • 58 Sutter Street, San Francisco 4, Calif. • Research-Cottrell (Canada) Ltd., 33 Bloor Street East, Toronto 5, Ontario.



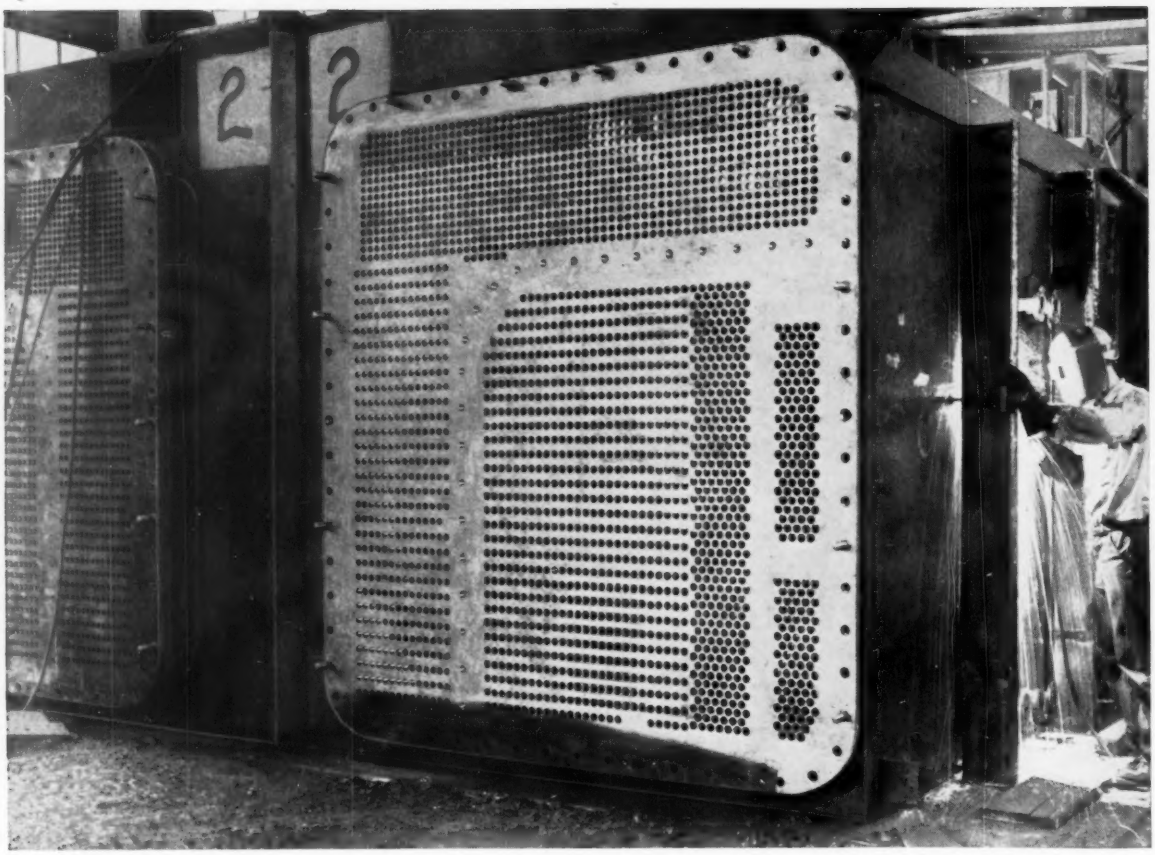
Cottrell
Precipitators



Cyclo-trell
Mechanical Collectors



Combination
Electrical-Mechanical
Collectors



C.H. Wheeler Reverse Flow Condenser prior to installation at Savannah Electric & Power Company's Riverside Station. Reverse Flow principle could save Savannah hundreds of dollars: leaves, twigs, algae and other foreign matter can be flushed from tubes and tube sheets without shutting down the unit.

BECAUSE Reverse Flow design eliminates hours of costly down time

C.H. WHEELER CONDENSERS SAVE YOU MONEY

Let's suppose the condenser tubes and tube sheets in your station become clogged. If your condenser is of conventional design and serves a 200,000 kw turbine, you'd need many hours to clean the tubes, and each hour you spend could cost as much as $330!*

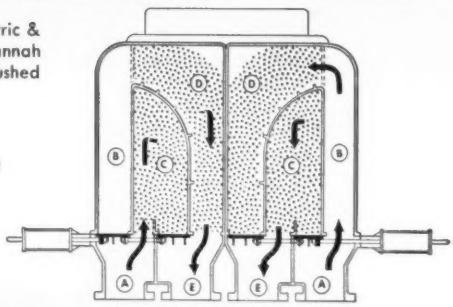
But with C.H. Wheeler's Reverse Flow design, you could flush away debris in a few minutes without shutting down the Condenser!

Reverse Flow is only one of the features of C.H. Wheeler Dual Bank Surface Condensers which save you money. Other money-saving features which result from Wheeler's 55 years experience in designing and building Condensers and auxiliaries, include better tube sheet design and advanced engineering of Tubejet® Steam Jet Ejectors, Condensate Pumps and Circulating Pumps.

*Based on an estimated cost of $8,000 per day for shutdown of a 200,000 kw Turbine-Generator.

C.H. WHEELER SAVES YOU MONEY IN THESE WAYS, TOO:

- Pure condensate
- Lower absolute pressure, higher vacuum
- "Zero" condensate temperature depression
- Deaeration to 0.03 cc. of oxygen per liter. (Special design provides for deaeration to 0.01 cc. per liter.)



HERE'S HOW THE "REVERSE FLOW" PRINCIPLE WORKS

Left Side Shows Normal Operation: Water enters inlet A with right port open, flows through tube bank C to rear of condenser; then it returns through tube bank D to front of condenser and discharges at point marked E.

Right Side Shows Reverse Flow: Sluice gates move on a common stem. Water flows up through channel B, through tube bank D to rear of condenser; returns through bank C to front of condenser.

In the C.H. Wheeler Divided Water Box design each half of the condenser can be back-flushed independently of the other; or both halves can be back-flushed simultaneously, with one or two circulating pumps operating.

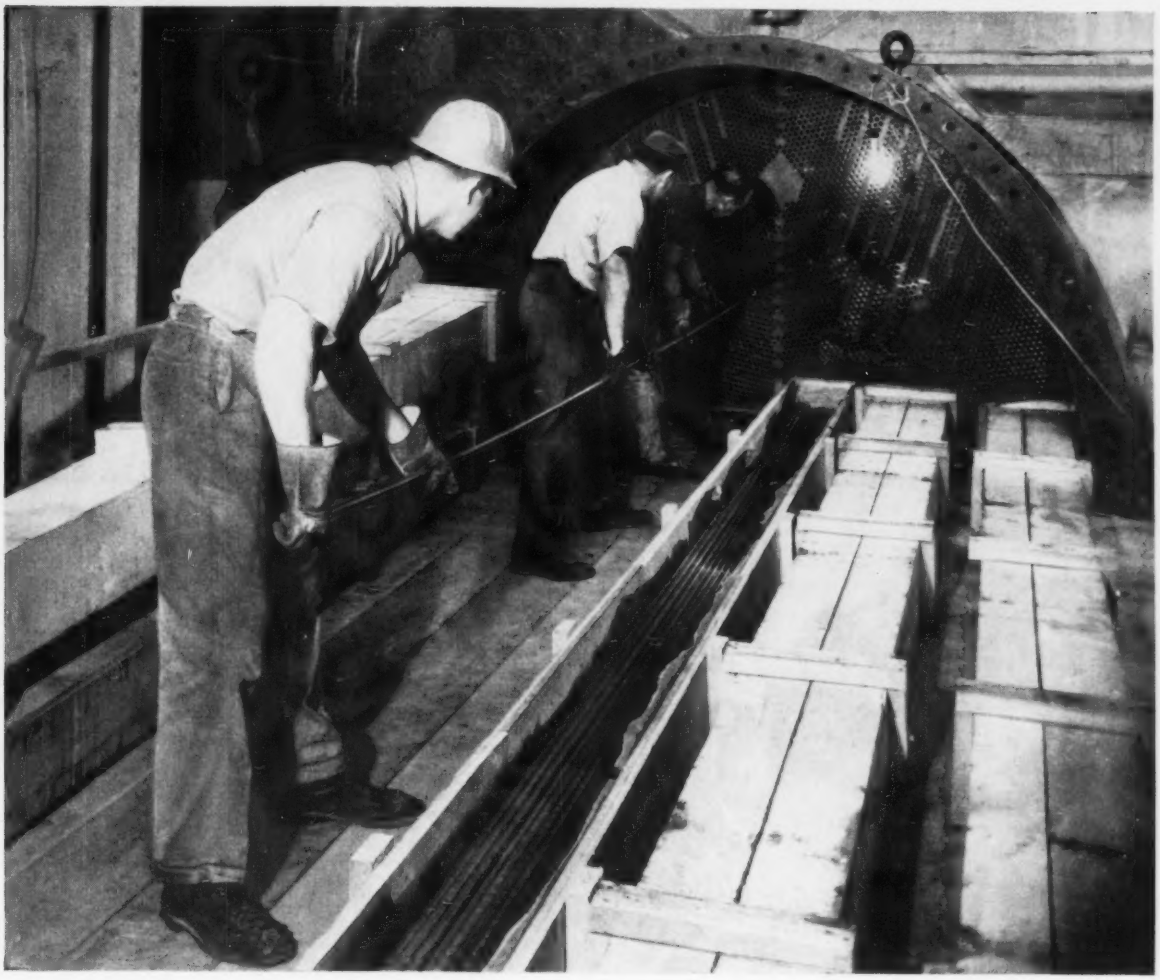
C. H. WHEELER MFG. CO.

19th and Lehigh Avenue • Philadelphia 32, Pennsylvania

Whenever you see the name C.H. Wheeler on a product, you know it's a quality product.

Steam Condensers • Steam Jet Vacuum Equipment • Centrifugal, Axial and Mixed Flow Pumps • Marine Auxiliary Machinery • Nuclear Products

TUBING OPERATION for divided water box, two-pass condenser. Complete unit has 95,000 sq. ft. condensing surface, serves 125,000 KW steam turbine-generator operating at 1,800 psi pressure, 1,000° F. steam supplied by 950,000 lbs/hr boiler.



OVER EIGHTY MILES OF CHASE CONDENSER TUBE!

East coast power company tubes condenser serving 125,000 KW generator unit

An east coast power company has recently completed tubing a condenser serving a 125,000 KW steam-turbine generator, using nearly 15,000 arsenical aluminum brass tubes, each 28′3¼″ long, by ⅞″ O.D.

Arsenical aluminum brass has proved itself in hundreds of installations of Chase Condenser Tube. Outstanding resistance to impingement attack makes it particularly suitable for use in tidewater power stations, aboard ship and in some oil field installations as well. Chase makes condenser tube to meet any combination of water type, temperature, speed of flow and corrosion conditions—and is ready to provide technical assistance in meeting specific problems, based on years of experience in manufacture and specification of condenser tube. Bring your needs to your nearest Chase Representative, or write Chase at Waterbury 20, Connecticut.

Chase®

BRASS & COPPER CO.

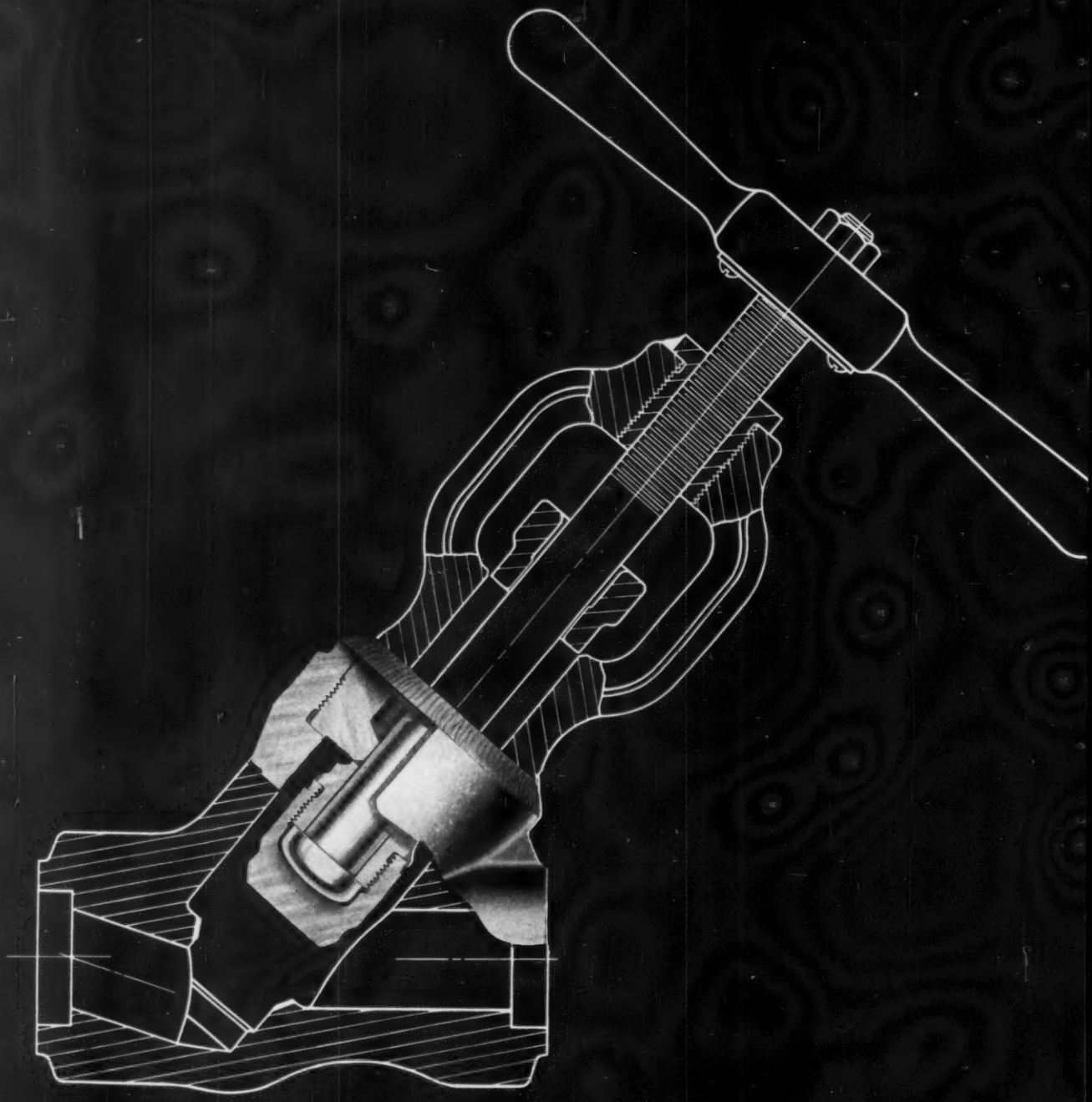
WATERBURY 20, CONN.

Subsidiary of

Kennecott Copper Corporation

The Nation's Headquarters for Brass, Copper and Stainless Steel

Atlanta Baltimore Boston Charlotte Chicago Cincinnati Cleveland Dallas Denver Detroit Grand Rapids Houston Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York (Maspeth, L.I.) Philadelphia Pittsburgh Providence Rochester St. Louis San Francisco Seattle Waterbury



EDWARD UNIVALVE

What's New from Edward Valves, Inc.

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

Shoulder, thread and weld make

Superior "Univalve" Body-Bonnet Joint

Edward valve researchers were assigned three main goals in developing the Univalve* . . . first, design a globe valve for high pressure-temperature service—that would *stay* leak-proof . . . second, eliminate—as far as possible—the necessity for maintenance . . . third, fabricate all pressure-containing parts of forged steel for maximum strength and soundness.

How well they succeeded is illustrated by this fact: in many hundreds of advanced temperature-pressure applications all over the world, Edward Univalves have given consistently superior service. The *reason* for this is simple . . . Univalves, properly maintained, simply do not leak.

WELD SEALS JOINT

In the Univalve, a bead of fine-grained weld seals the body-bonnet joint to maintain perfect pressure tightness in any service. A guiding section above the threads protects them from the seal-weld; the threaded section and body shoulder carry the pressure load and insure accurate alignment. The rugged threaded bonnet—with opening just large enough to accommodate the stem—provides a pressure-tight backseat. The radiused disk nut contacts the beveled bonnet backseating surface . . . isolates packing from line pressures and temperatures . . . stretches packing life.

While the Univalve rarely needs attention, even its tough integral Stellite seating surface *can* become scored under some conditions. To strip for inspection and possible re-lapping, the seal-weld is easily removed by machining or grinding or with carbon arc or oxy-acetylene scarfing tip. Besides simple disassembly and positive backseat advantages, Univalve's one-piece gland eliminates possible small parts loss during repacking.

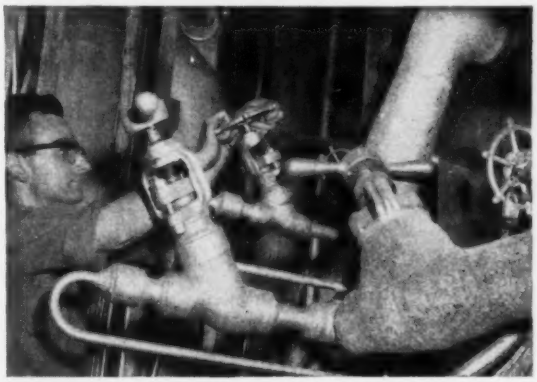
IMPORTANT UNIVALVE FEATURES:

Streamlined Flow Path reduces pressure drop, minimizes wear-producing turbulence. Univalve meets requirements for blow-off service.

Simple Packing Adjustment keeps packing maintenance down. Sturdy gland bolts, roomy yoke, one-piece forged gland.

Easy Open—Tight Close Operation of all Univalves 1¼" to 2½" made a reality with the exclusive Edward Impactor* handle.

Continuous Stellite Ring applied to body and disk, retains hardness under temperature and resists wear.



4500 LB UNIVALVE in service at Ohio Power Company's supercritical Philo station.

*T.M. Reg. U.S. Pat. Off.

IDEAL FOR BLOW-OFF SERVICE. Univalves meet ASME Code for blow-off service and are adaptable for all high pressure installations.

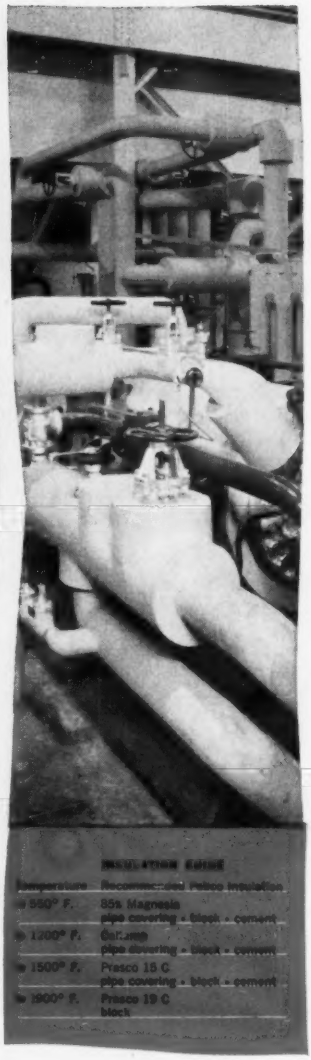
EDWARD VALVES, INC.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1230 West 145th Street, East Chicago, Indiana

Edward builds a complete line of forged and cast steel valves from ⅛" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 7500 lbs; with pressure-seal, bolted, union or welded bonnets; with screwed, welding or flanged ends.

Complete control
of temperatures with
PABCO
PRECISION-MOLDED
CALTEMP
a Calcium Silicate
Insulation



Name your temperature. A performance-proved Pabco pipe or block insulation will maintain it at economical levels up to 1900° F. With Pabco Caltemp, 85% Magnesia, or Prasco Insulations, heat losses are reduced to an absolute minimum . . . finest performance assured. For data on technical advantages, case histories, or engineering consultation . . . write . . . or contact one of Pabco's insulation engineers.

PABCO INDUSTRIAL INSULATIONS DIVISION

Fibreboard Paper Products Corporation • San Francisco 19 • Chicago 54 • Houston 4 • New York 16 • Los Angeles

ALLIS-CHALMERS

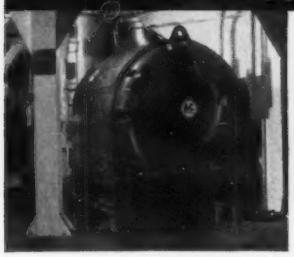
Plan to stay ahead... MODERNIZE!

NEW brochure of ideas for modernizing

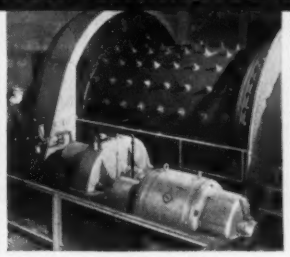
This booklet is based on the premise that modernization can start anywhere in your plant. It can be a single machine or operation . . . a better way of getting variable speed . . . a faster way to braze . . . or a newly available replacement. In fact, this type of updating is far more common than the sweeping change.

Get a copy of "59 ideas for modernization in '59" from your nearby A-C office or write Allis-Chalmers, Industries Group, Milwaukee 1, Wisconsin.

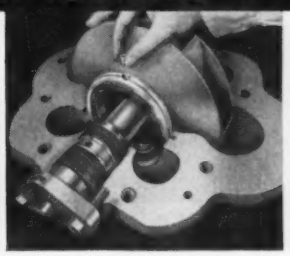
Typical examples of updating ideas!



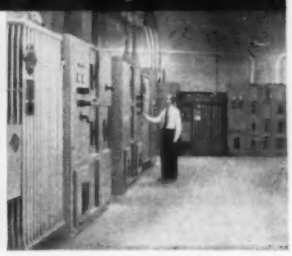
New motor development may eliminate premiums you've been paying for specially protected motors.



Using one grinding mill in place of two can improve product quality as well as saving space and labor.



Jamming and clogging in double-suction pumps can be eliminated by pumps with adjustable wearing rings.



Electrical modernization includes placing substations close to machines being served. Roof or basement is often the answer.

A-C ALLIS-CHALMERS

A-5851

ALLIS-CHALMERS STEAM TURBINE-GENERATOR UNITS

4 Basic Types for

Select from Condensing . . . Non-Condensing . . . Condensing Automatic Extraction . . . and Non-Condensing Automatic Extraction Types

ALLIS-CHALMERS WA-Series steam turbine-generator units are built in NEMA ratings from 2000 through 10,000 kw, and AIEE-ASME preferred standard ratings up to and including 16,500 kw.

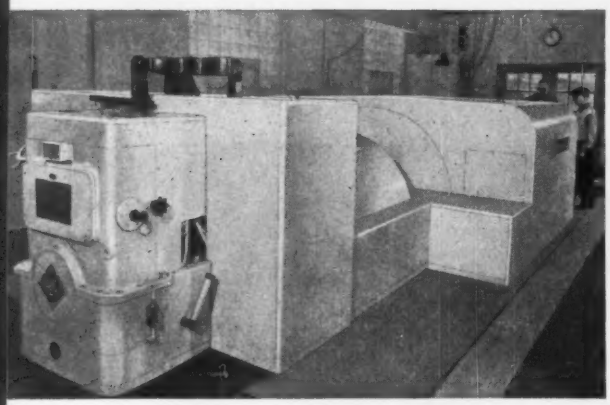
Both utility and industrial service requirements can be filled from this broad line of modern machines.

Turbine, generator and exciter are carefully engineered to operate as a unit. Oil piping and generator gas coolers are located above the floor line to eliminate trenching and duct-work . . . facilitate installation.

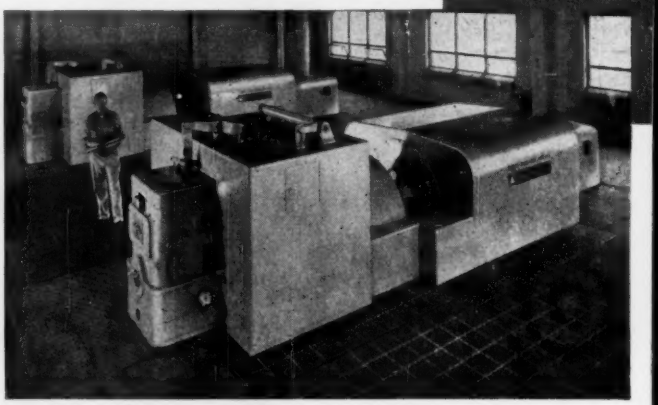
Other features include a self-contained lubrication system, metallic labyrinth-type steam seals, and unit shipment of assembled machine.

For detailed information and help in selecting the type and size unit for your requirements — from 2000 to 500,000 kw, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wis.

Condensing — This 16,500-kw steam turbine-generator is hydrogen cooled, and is typical of the largest WA-Series units.



Non-Condensing — Power and process steam for a paper manufacturer are supplied by this Allis-Chalmers 4000-kw unit.



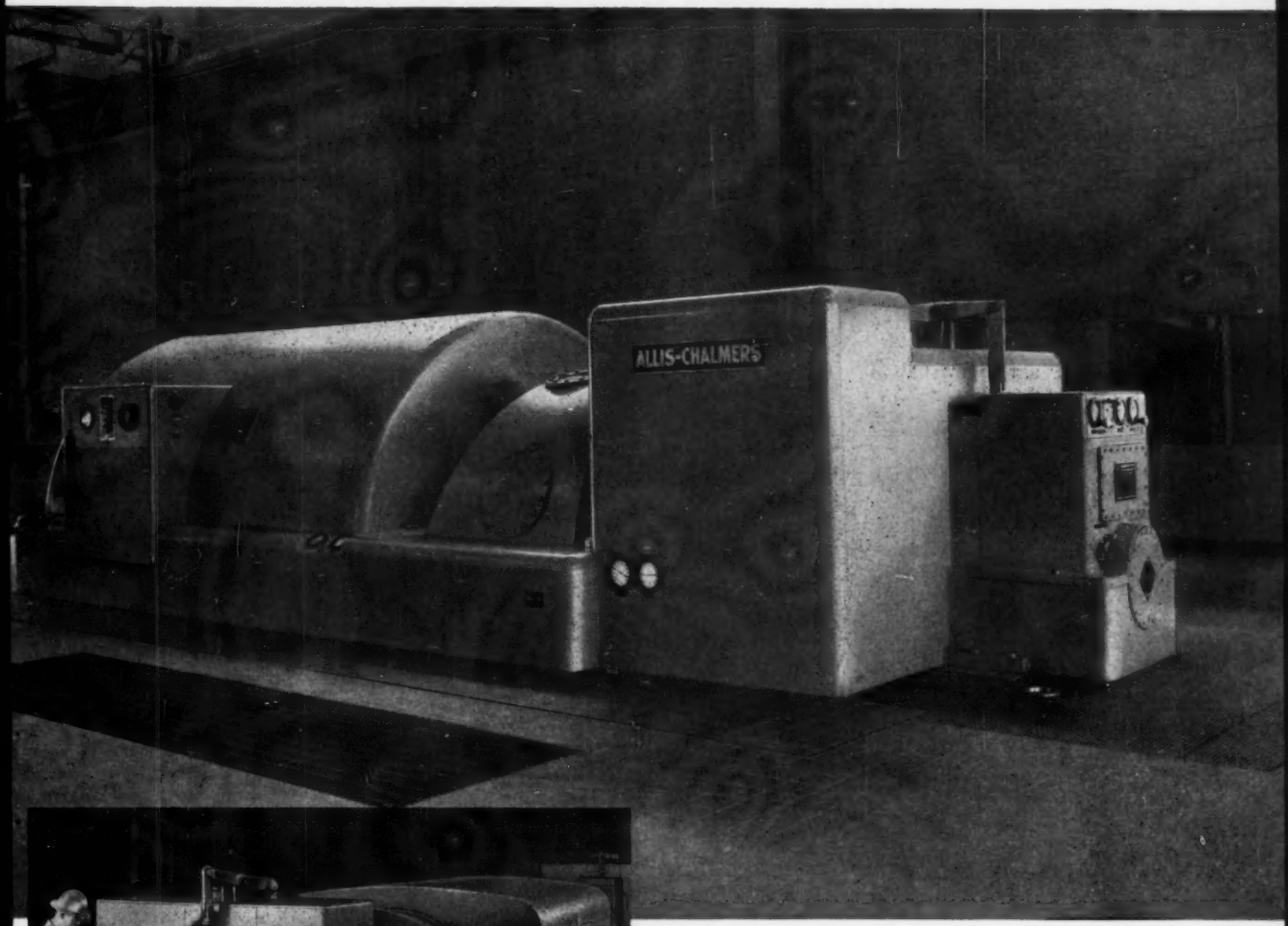
Non-Condensing Automatic Extraction — These two 3000-kw units in power plant of hospital provide by-product power. Process steam is used for laundry, cooking, heating, and sterilizing.

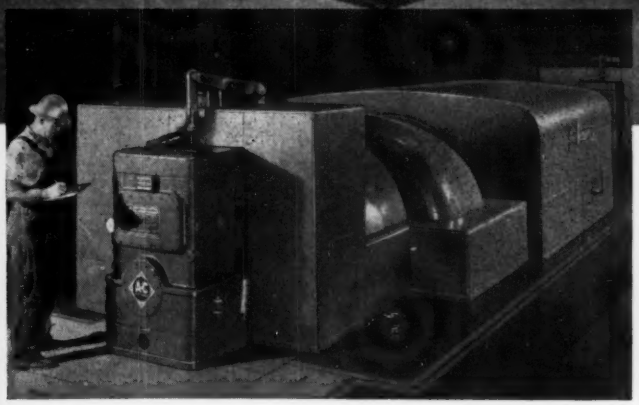
A-C ALLIS-CHALMERS

ALLIS-

2000 to 16,500 Kw

Modern Power Plants

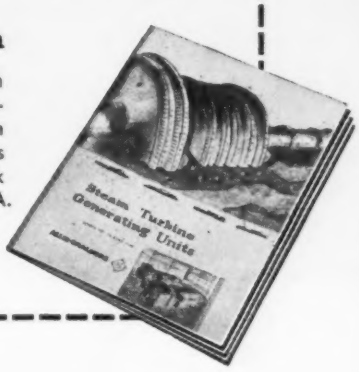




Condensing Automatic Extraction — Power is generated as a by-product of process steam needs at this chemical company. Two 5000-kw Allis-Chalmers steam turbine-generators are used.

New Bulletin

New 40-page bulletin provides detailed engineering information about Allis-Chalmers WA-Series units. Ask for Bulletin 03B7654A.

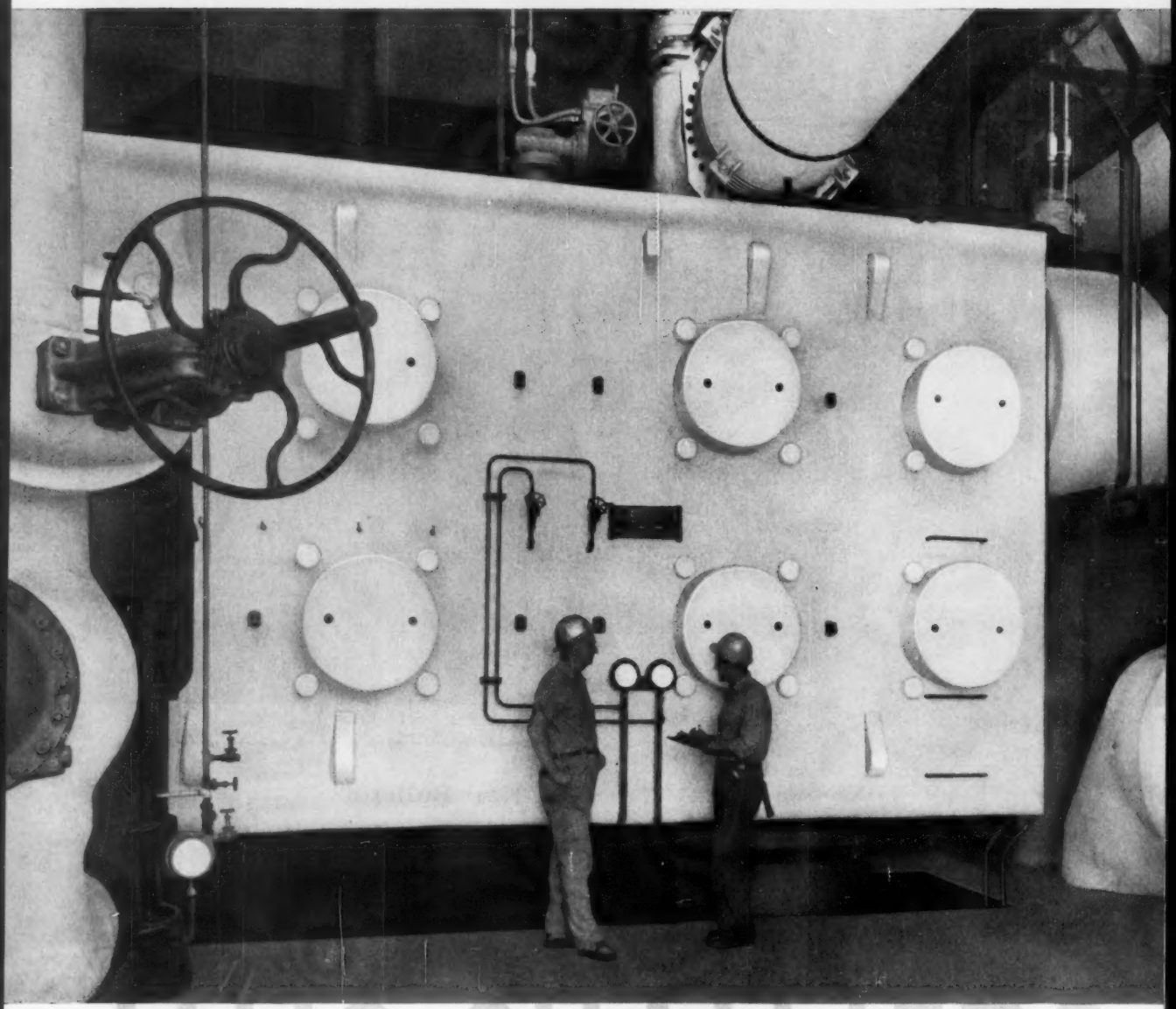


CHALMERS

ALLIS-CHALMERS

Another Example of Allis-Chalmers

One-half of the twin condensing unit, together with 67,000-gpm circulating water pump, in service at Waukegan Station Unit No. 7 since June 11, 1958.



ALLIS-CHALMERS

Condenser Leadership

180,000 square foot condenser

. . . largest in operation

First 325-mw turbine in operation served by A-C condenser at Commonwealth Edison, Waukegan Station.

This single-pass, twin condensing unit, with its 180,000 square feet of surface, breaks a record for size originally established by Allis-Chalmers units built in 1927 (also for Commonwealth Edison at State Line Generating Station).

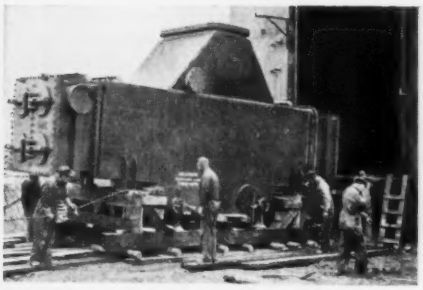
Of special interest to utility men is the use of aluminum tubes. Over 20,000 of these tubes went into this condenser.

Condenser shells are connected to maintain balanced conditions. In addition, the divided water boxes are connected so that any combination of one or more circulating pumps will operate the condensing plant.

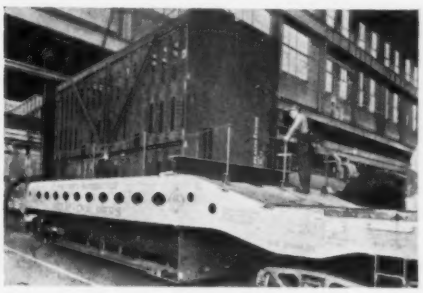
The four circulating pumps and three condensate pumps, as well as motors, were also built by Allis-Chalmers.

Allis-Chalmers has the experience, the facilities, and the backup of auxiliary equipment to meet your special problems.

Get information! Call your nearby A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.



First condenser for first commercial-type nuclear power plant in operation is Allis-Chalmers 5300-sq-ft unit with aluminum tubes, double tube sheets, special leak tightness.

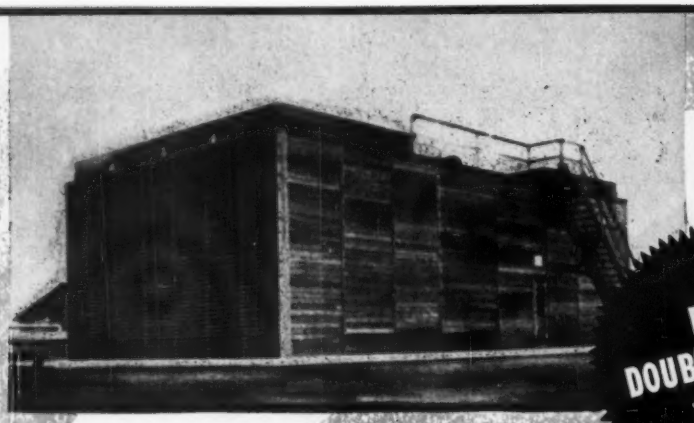


First with specially built "well-center" freight cars to accommodate large condenser sections, thereby reducing shipping problems, cutting installation time and costs.

First welded tube condenser prevents condensate contamination, meets problems of supercritical pressure.

ALLIS-CHALMERS

A-5843

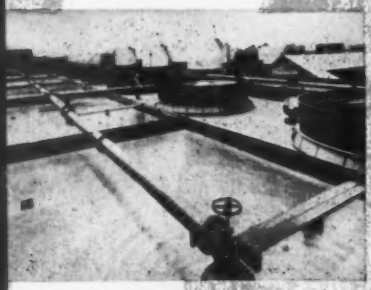


20 Years

First DOUBLE-FLOW 1938

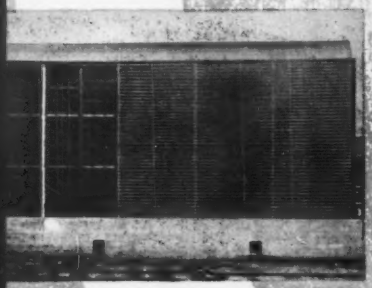
Highlights of Progress
in Double-Flow Design Down Through the Years

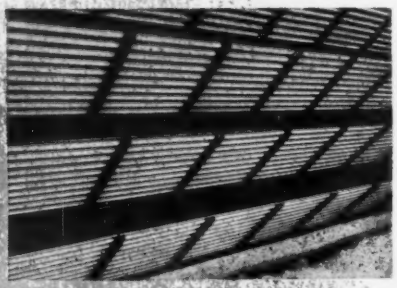
In 1938, The Marley Company introduced a new cooling tower that was to prove to be the most important single advancement in the entire history of industrial water cooling — the Marley Double-Flow. Far from being just an improvement or refinement of existing cooling towers, the Double-Flow was an entirely new concept of water cooling based on the revolutionary cross-flow principle of a single fan serving two cooling cells by drawing air *horizontally* across both cells.



The original single-elevation fan deck (left) has been replaced by the more efficient elevated deck with heavy unitized steel equipment supports; the modern velocity recovery fan stack is an important, functional part of Double-Flow cooling towers.

Since that time, more than 2000 Double-Flows, involving more than 6000 fan cells, have been put into industrial service, and the billions of gallons cooled daily by Double-Flows exceed installed capacity of any other type of tower. The Double-Flow has become, by any standard of measurement, the Number One Industrial Cooling Tower, both at home and abroad.

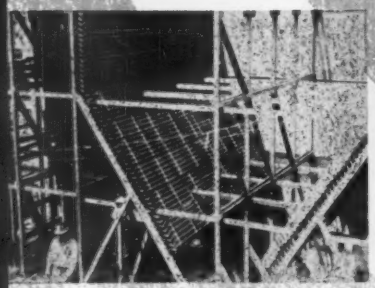


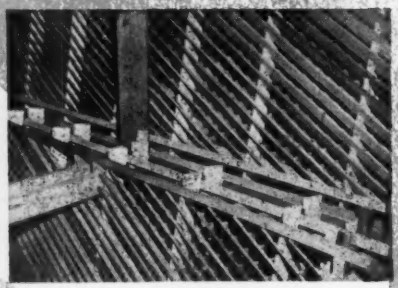


The full-height louvered face remains but new, broad louvers on wide centers open it up for maximum air passage with little draft loss; they also prevent restriction of air travel by ice formation.

Performance has keyed Double-Flow's popularity over the past two decades; **performance** that is a matter of record, based on valid and published tests. **Dependable performance**—earliest Double-Flows are still in daily service. **Continually-upgraded performance**—Marley has constantly improved fans, fan cylinders, drift eliminators, fill, mechanical equipment . . . every functional and structural element . . . all to further its goal of "moving more air to cool more water more efficiently".

The Marley Company believes that the ultimate in cooling towers is "always building, never built" . . . and is proud to present the new Class 600 Double-Flow that embodies many new and important advancements in water cooling practice and achievement.





Drift eliminators in the original Double-Flow were the most efficient of that period. Herringbone eliminators in Class 600 Double-Flows remove more entrained moisture and reduce the static pressure drop.

Marley equipment and components covered by U. S. and Foreign Patents and Patents Pending

and 2000 Double-Flows later

Marley Class 600 Double-Flows

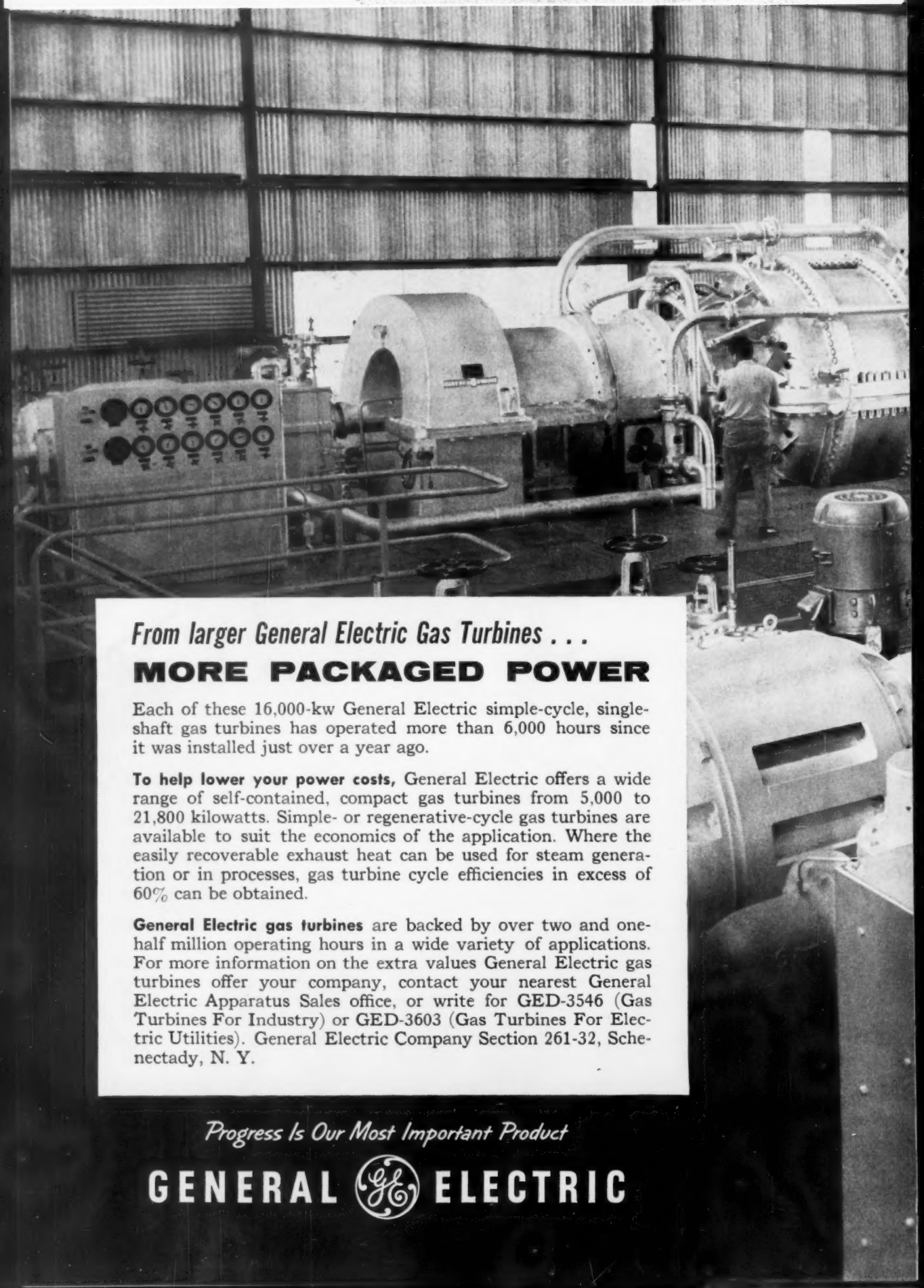
again revolutionize water cooling!

The Class 600 Double-Flow is unusual in profile, unprecedented in performance—and here are the highlights: Angular sidewall construction and fill of uniform width at all elevations permits increased cooling capacity in every frame size with greater power economy and conservative basin cost . . . from the new wide angle louvers to the fan, air flow is cleared of obstructing elements, resulting in lower draft loss, more efficient air movement . . . angled louvered walls prevent splash-out, prevent winter icing . . . new inert materials throughout tower extend service life. Get complete information on these modern cooling towers from the Marley engineer in your city or write The Marley Company.

The Marley Company

Kansas City, Missouri

MARLEY®



From larger General Electric Gas Turbines . . .

MORE PACKAGED POWER

Each of these 16,000-kw General Electric simple-cycle, single-shaft gas turbines has operated more than 6,000 hours since it was installed just over a year ago.

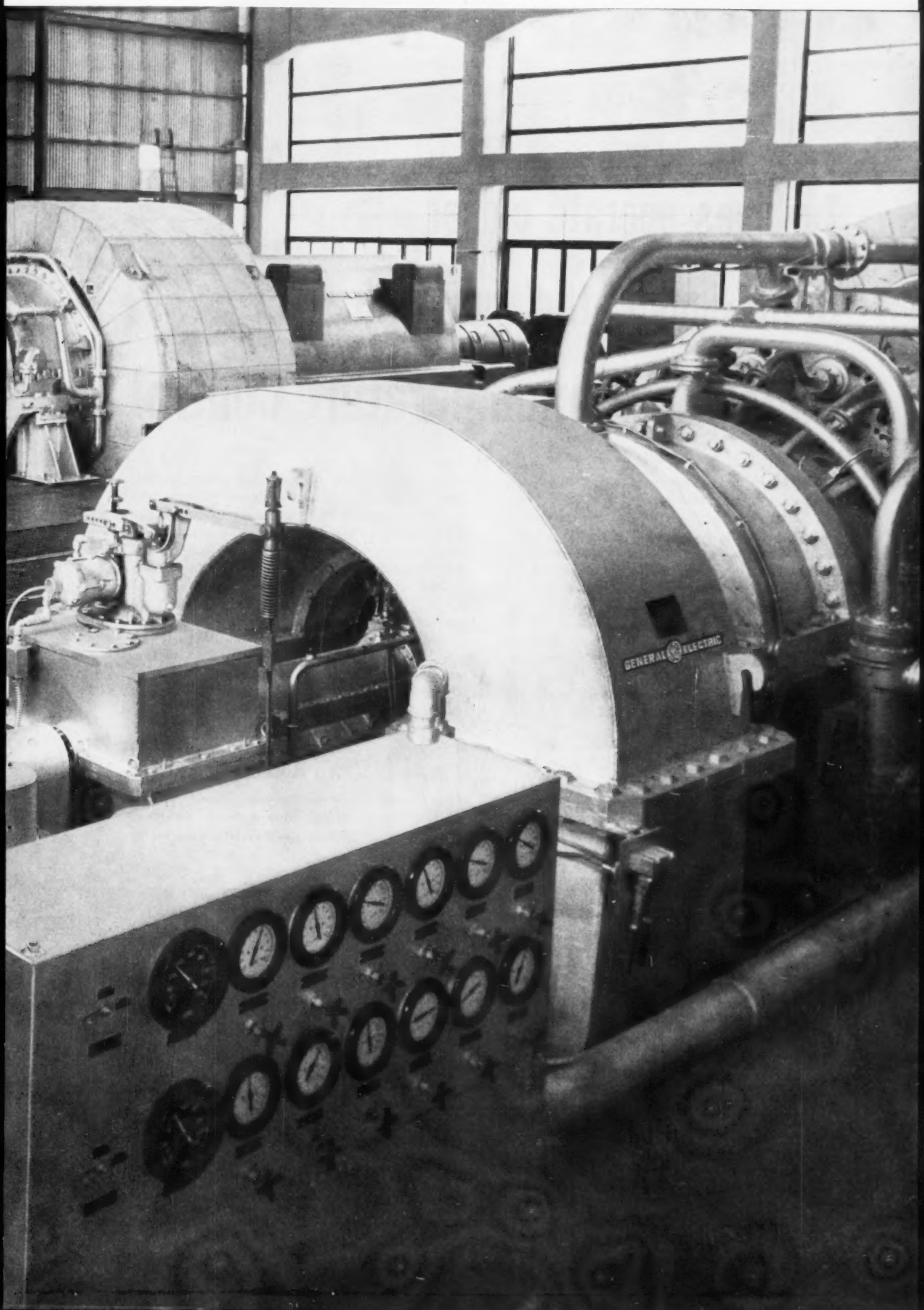
To help lower your power costs, General Electric offers a wide range of self-contained, compact gas turbines from 5,000 to 21,800 kilowatts. Simple- or regenerative-cycle gas turbines are available to suit the economics of the application. Where the easily recoverable exhaust heat can be used for steam generation or in processes, gas turbine cycle efficiencies in excess of 60% can be obtained.

General Electric gas turbines are backed by over two and one-half million operating hours in a wide variety of applications. For more information on the extra values General Electric gas turbines offer your company, contact your nearest General Electric Apparatus Sales office, or write for GED-3546 (Gas Turbines For Industry) or GED-3603 (Gas Turbines For Electric Utilities). General Electric Company Section 261-32, Schenectady, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Kansas City, Missouri



Turbines operate closer to maximum efficiency with Hagan Steam Temperature Control

The closer turbines can operate to their maximum design temperature, the more efficient their operation. Hagan's steam temperature control system permits a closer approach to this optimum figure through extremely sensitive temperature measurement and the maintenance of very stable control despite narrow proportional band settings.

The chart shown is from Commonwealth Edison's Will County Station, and is typical of the results produced by this Hagan system. Utilizing Hagan's PowrAmp for amplification, the system is sensitive to temperature changes of 1°F or less. Ratio Totalizers are employed for derivative action, as controllers and for signal combining. For example, the system includes a signal from steam flow so that load changes can be anticipated.

Valves and dampers are operated by Hagan Power Positioners, which provide the necessary power, accuracy and speed to keep up with the rest of the system. The use of a suppressed scale enables the system to maintain closer control, and the high stability of the system permits fully automatic control, even under fluctuating loads.

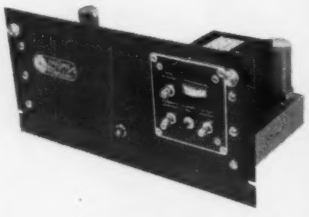
Hagan steam temperature control systems are in use on all types of boilers. Temperature control is achieved by flue gas recirculation, by various types of attemperation, by split firing, by burner tilt or by a combination of these methods. Temperature sensing and amplification may be either pneumatic or electronic, as shown below.

A Hagan engineer would be glad to explain exactly how a Hagan system can add to production efficiency. Write or phone Hagan at the address below, or the Hagan office nearest you.

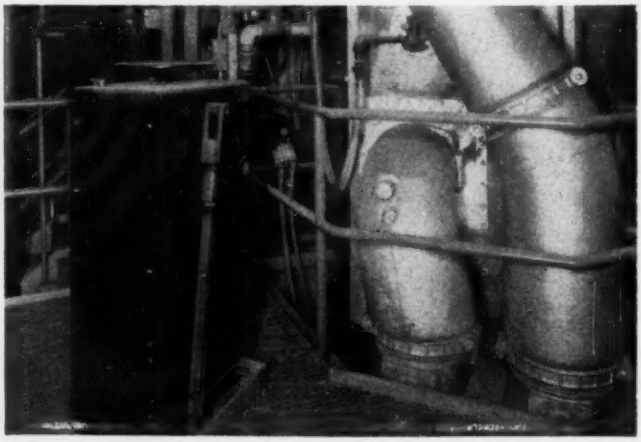
HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY • HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

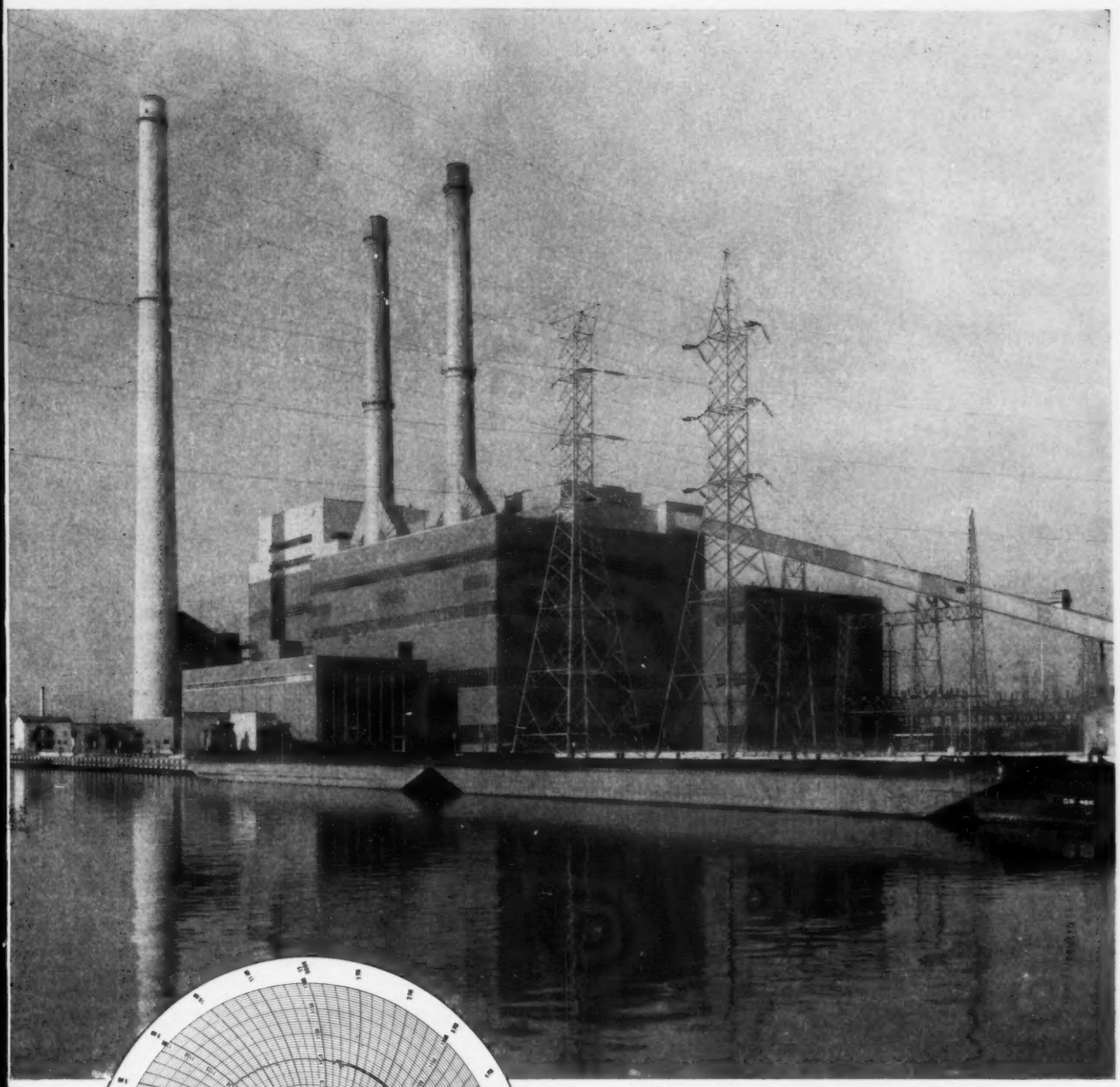
Hagan PowrAmp Amplifier is used with thermocouples for high speed response and ± 0.25% accuracy. Sensitive to very small temperature changes, PowrAmp equipment has a high degree of stability, and permits very close approach to optimum operating temperatures.



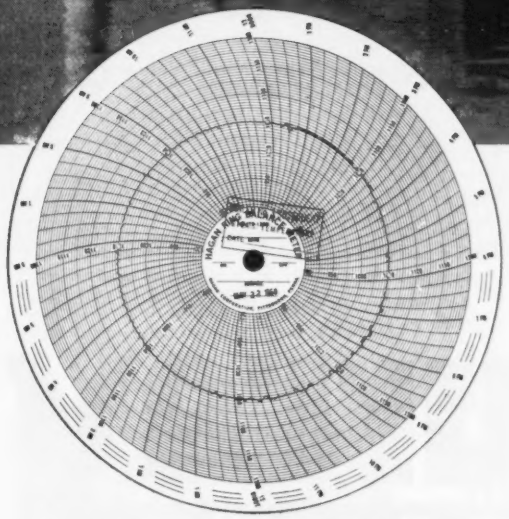
Hagan Pneumatic Thermostat provides practically instantaneous response to temperature changes and a high degree of accuracy. Generating a pneumatic output signal, it is suitable for measuring and controlling temperatures up to 1200°F at static pressures up to 2400 psig.



Hagan 8 x 14 Power Positioner controlling burner tilt. Precise and rapid response to control signals provides maximum possible regulation of superheat temperatures, reducing need for attemperation.



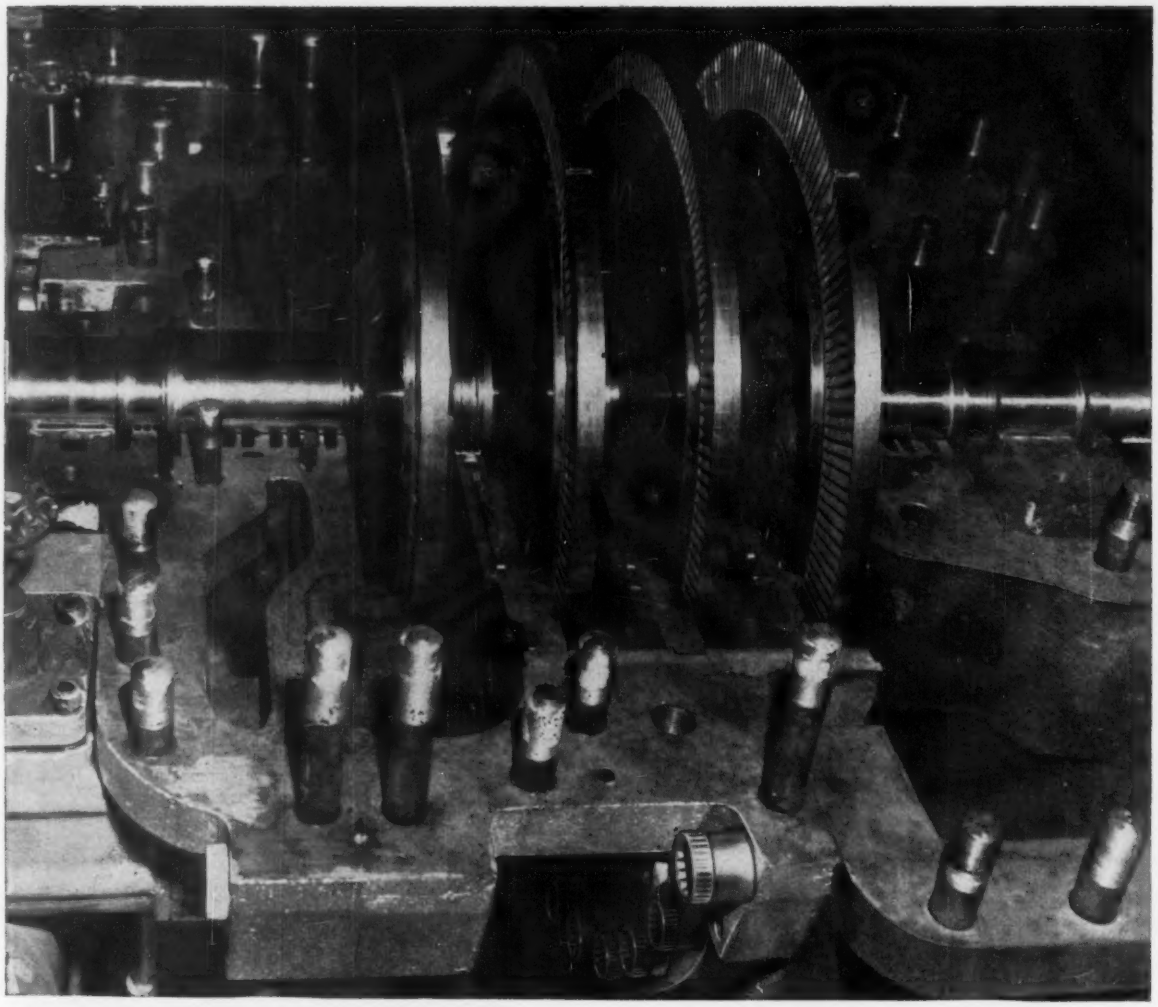
Will County Station, Commonwealth Edison Company, has Hagan Steam Temperature Control on Unit No. 3.



Typical superheat steam temperature chart with Hagan control. Note that chart range is 900° to 1200°, so that maximum swing recorded is approximately 5°.

These are some of the Electric Utilities who have purchased Hagan Steam Temperature control systems for one or more units:

Arkansas Power & Light Company
Carolina Power & Light Company
Commonwealth Edison Company
Consolidated Edison Company of New York, Inc.
Detroit Edison Company
Duquesne Light Company
Missouri Public Service Company
Montaup Electric Company
Niagara Mohawk Power Corporation
Orlando Utilities Commission
Tampa Electric Company
Texas Power & Light Company



THE INSIDE STORY OF A MURRAY HIGH SPEED COMPRESSOR

DRIVE TURBINE REVEALS THE REASONS FOR MURRAY'S UNIVERSAL ACCEPTANCE

A look at MURRAY'S rugged construction from the inside shows the husky shaft and heavy accurately formed discs with generous sized hubs designed to withstand the axial and radial stresses imposed by this type of service.

Large-dimension disc rims receive the specially contoured stainless steel blades with the Murray integral shroud. This insures smooth steam passages with maximum strength.

Short bearing spans insure smooth operation and eliminate the hazard of operating in critical speeds.

A look at the heavy flanges and husky bolting in the actual unretouched shop photo shown above bears out the extreme ruggedness that typifies every feature of Murray construction.

Our nearest representative will gladly help you solve your high speed compressor drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa, for his name.

Murray
TURBINES

MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA
Builders of Steam Power Equipment for Nearly a Century

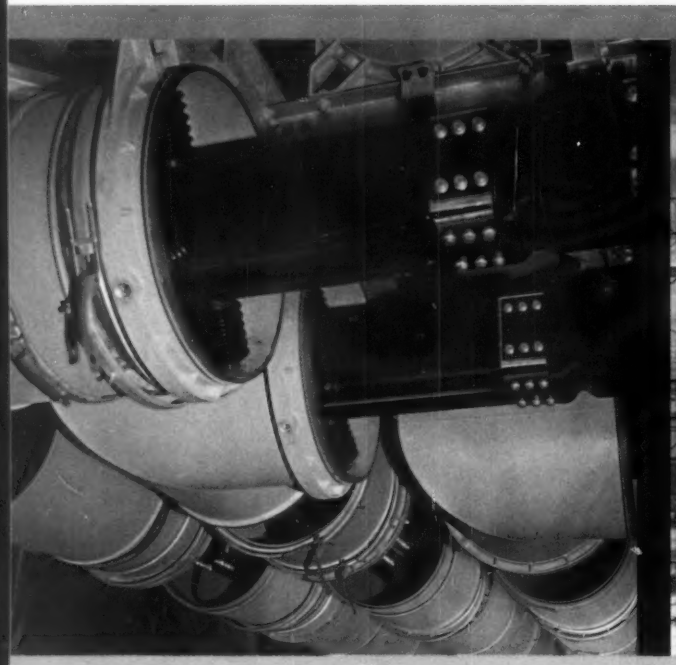
Pacific Gas and Electric Company's Morro Bay Power Station is an outstanding example of clean, modern lines achieved with ribbed walls of Alcoa Aluminum.

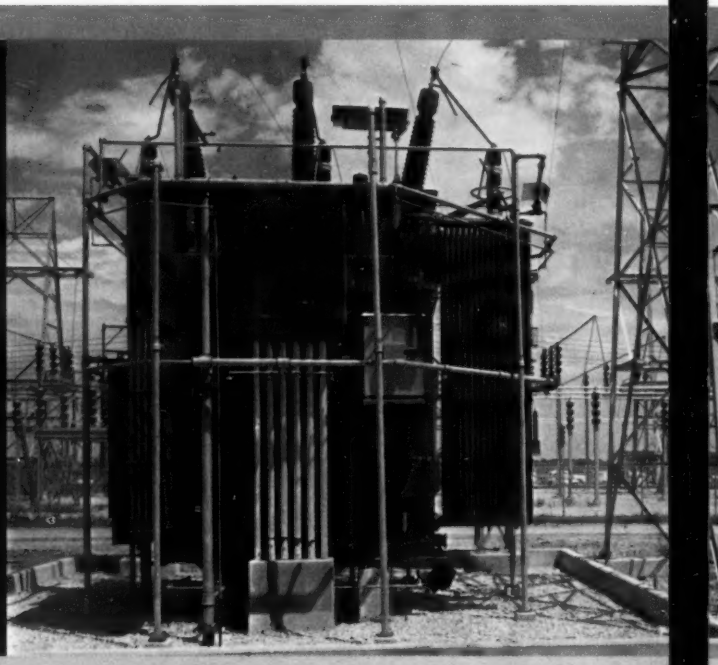
ALCOA RESEARCH

. . . development today for tomorrow's loads

HOW ALCOA ALUMINUM REDUCES COSTS IN GENERATING STATIONS

ALCOA'S THREE-PRONGED ASSAULT ON POWER STATION COSTS





ARCHITECTURAL APPLICATIONS

There are three outstanding reasons why Alcoa Aluminum is the ideal building material for generating stations: low cost, freedom from maintenance and attractive appearance.

Walls of Alcoa Aluminum, uninsulated or sandwich type, go up fast. They require less supporting steel and a lighter foundation. They never need painting. Yet *sandwich wall of Alcoa Aluminum is the lowest cost, insulated metal wall system available.* Savings are also found in roofing, windows, conveyor framing and covers, handrails, grating, tread plate, fencing and many other applications. In every case, strong, lightweight Alcoa Aluminum offers a substantial bonus in corrosion resistance and permanent good looks.

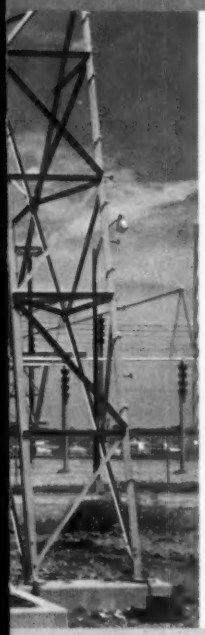
Right: Maintenance-free beauty . . . Duke Power Company's Allen Plant at Belmont, North Carolina.

Through the years, Alcoa has adapted aluminum to new uses in power stations in three areas: electrical, architectural and mechanical. In every case, the objective has been the same: to reduce costs while advancing standards of performance. The result today is virtually an "all-aluminum" power station from conductors to condenser tubes, siding to stair treads. Everywhere you look, aluminum is helping utilities produce more kilowatts per dollar.

ALCOA
ALUMINUM
ELECTRICAL CONDUCTORS AND ACCESSORIES
ALUMINUM COMPANY OF AMERICA

ALCOA RESEARCH

. . . development today for tomorrow's loads

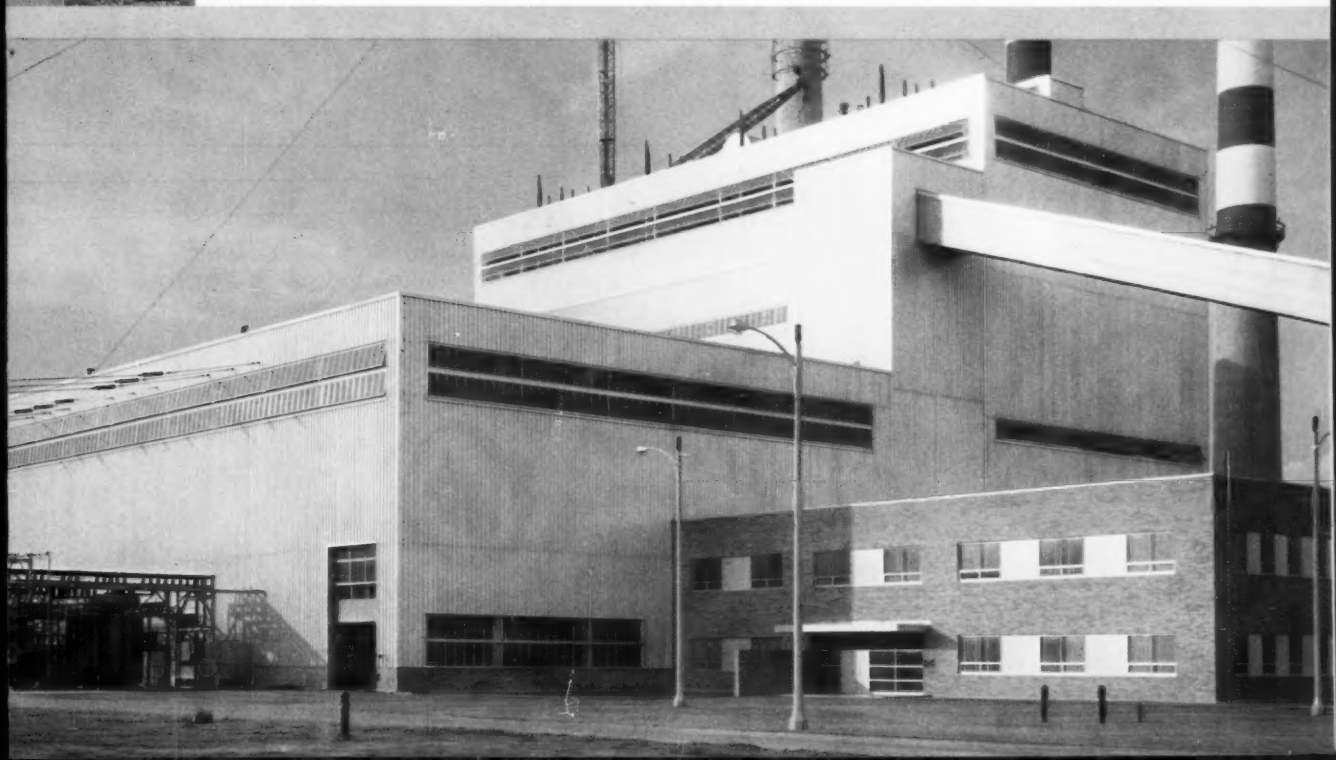


ELECTRICAL APPLICATIONS

The same economy that accounts for almost universal acceptance of aluminum in overhead lines is yours if you specify aluminum for your power station. Alcoa® Bus Conductor, for example, is saving utilities many thousands of dollars, since an equivalent installation costs about one-half as much as copper. Conduit, crossarms and structures, cable, generator field windings, switchgear and isolated phase bus and enclosures, transformer windings and yoke end plates all represent opportunities for savings with Alcoa Aluminum. Soon transformer tanks and radiators will be available in aluminum. All these applications pay major dividends in lower maintenance costs, longer life and higher efficiency.

Left: Alcoa Rigid Conduit is used on this transformer at Kansas City Power & Light Company's Montrose Steam-Electric Generating Station.

Far left: Isolated Phase Bus made by Delta Star Division of H. K. Porter Co., Inc., with Alcoa Integral Web Channel Bus connected with aluminum bolts, aluminum enclosures and cast aluminum support rings at Commonwealth Edison Company's Fisk Station.



MECHANICAL APPLICATIONS

Among the foremost mechanical applications of aluminum are heat exchanger tubes. Low cost, as much as 50 to 60 per cent below other tubes, is combined with long life and superior resistance to carbon dioxide, hydrogen sulfide and ammonia. Moreover, heat transfer characteristics are equal to the best of competitive metals.

Aluminum's resistance to corrosion also accounts for major economies in condensate storage tanks, since no maintenance is required inside or outside and no iron is introduced into boilers.

In numerous applications including control tubing, tanks, covers, boiler lagging, jacketing, panels, canopies and low-pressure feedwater heaters, aluminum can help utilities to save on initial cost, on maintenance, through longer service—or all three.

Condenser tubes of Alcoa Aluminum being installed in an Allis-Chalmers Mfg. Co. surface condenser at The Detroit Edison Company's St. Clair Station.

Find out more about the use of aluminum in power stations. *Alcoa Aluminum for Generating Stations* is a new booklet listing many of the latest applications of aluminum in this field—electrical, architectural and mechanical—and containing a complete list of all Alcoa literature available on each of these subjects. It's "must" reading for every cost-conscious utility executive. For your copy, write Aluminum Company of America, 2301 Alcoa Building, Pittsburgh 19, Pennsylvania.

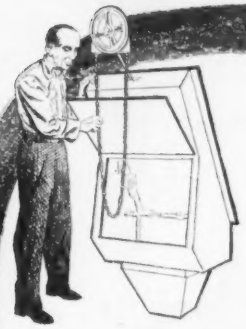
For more information on *any* application of aluminum in the electrical industry, call Alcoa.

ALCOA ALUMINUM
ELECTRICAL CONDUCTORS AND ACCESSORIES
ALUMINUM COMPANY OF AMERICA

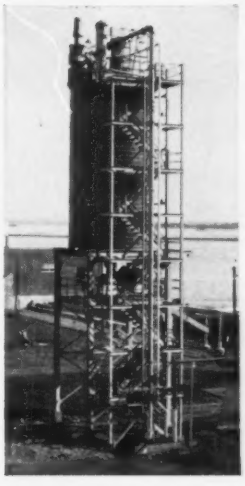
ALCOA RESEARCH

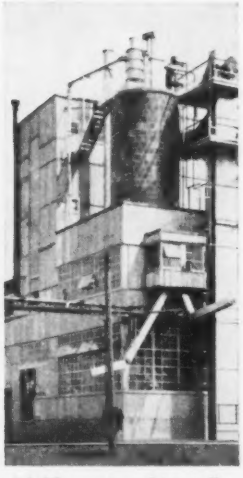
. . . development today for tomorrow's loads

ALCOA THEATRE
Fine Entertainment, Alternate Monday Evenings

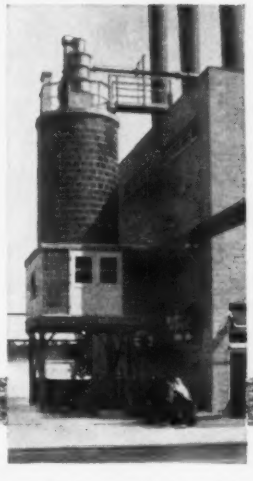


100 ton Ash Silo straddling R.R. track with full stairway to roof. High capacity Ash Conditioner on open platform with discharge to R. cars.





Ash Silo constructed integrally with boiler house. Ash Conditioner mounted inside building. Bifurcated chute allows R.R. car or truck loading.



Ash Silo for truck loading with enclosed room for ash conditioner.

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These fine organizations, and hundreds like them, choose National for

ASH REMOVAL AT LOWER COST

Interested in Ash Conveying equipment? Ask your nearest *National* representative to show you, without obligation on your part, how costs can be cut with a National Steam-operated Pneumatic, Hydraulic or Motor-driven System. National offers a nation-wide installation service — high operating efficiency — rugged, wear-resistant pipe and fittings that provide lower maintenance cost per ton of ash conveyed. Consult National now — one contract covers everything, from inception to finished installation. Write us, or nearest representative listed below.

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Bulletin P57-A
on pneumatic ash conveyors

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on hydraulic ash conveyors

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FAIRVIEW, BERGEN COUNTY, N. J.
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Also manufacturers of: **National ChipVeyor Systems** for the collection and processing of metal chips and borings and reclamation of cutting oils (Send for Bulletin C-56). **Conveyors** for press scrap and small parts and **Pneumatic Systems** for handling dry granular materials (Bulletin P-58G).

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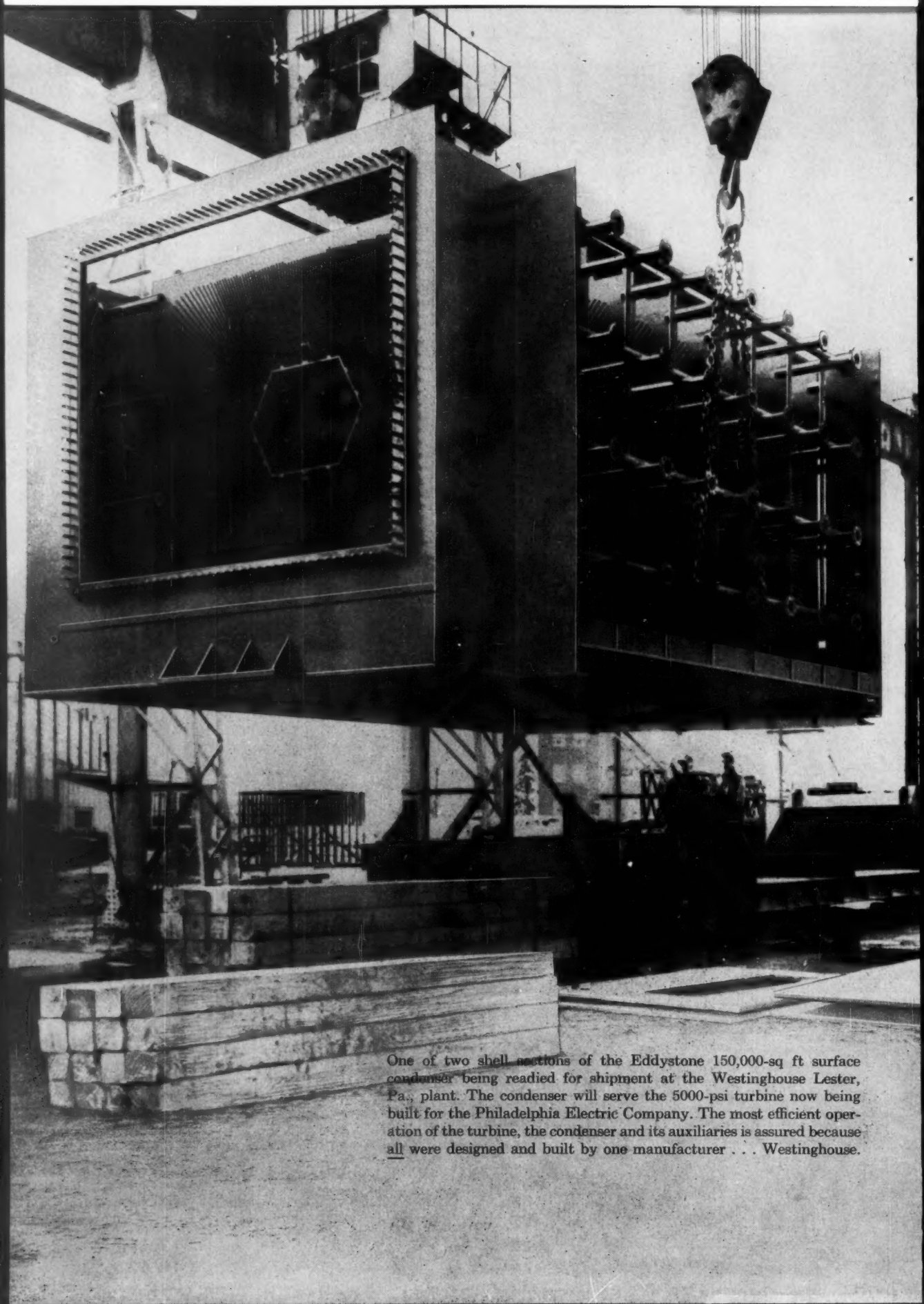


One of two shell sections of the Eddystone 150,000-sq ft surface condenser being readied for shipment at the Westinghouse Lester, Pa., plant. The condenser will serve the 5000-psi turbine now being built for the Philadelphia Electric Company. The most efficient operation of the turbine, the condenser and its auxiliaries is assured because all were designed and built by one manufacturer . . . Westinghouse.

New Westinghouse Condenser will help Eddystone 5000-PSI Turbine set world's efficiency record

ANOTHER GIANT STEP has been taken towards the completion of Philadelphia Electric Company's Eddystone station.

Westinghouse has shipped the 150,000-sq ft surface condenser to serve the world's most efficient turbine. Now being built by Westinghouse, the Eddystone turbine will use the highest temperature and pressure steam ever projected...5000 psi at 1200°F.

New Condenser

Because the Eddystone station will use a once-through steam generator, Westinghouse and Philadelphia Electric engineers jointly developed several new features for this surface condenser. *Both of these Westinghouse "firsts" were announced to the industry during the early design stages.*

The detection and location of even *small* leaks are made possible by twenty sampling compartments in the condenser's upper hotwell and collecting trays below the tube sheets. The lower hotwell is divided into three sections, and if any one becomes contaminated, the condensate can be by-passed into a water tank.

Through the second feature, during start-up or in the event of a trip-out or emergency, steam must be diverted from the turbine to the condenser. To protect the condenser from high-pressure and high-temperature steam, this steam is passed through four condenser injection coolers, which act as desuperheaters and pressure reducers.

Fifty Years of "Design Firsts"... Through Plowback of Earnings into Research

The installation of this Westinghouse condenser marks the 50th anniversary of Westinghouse research in designing and building surface condensers. During the past 50 years, Westinghouse has developed many of the *basic* condenser designs that today help the industry to produce low-cost electricity. Westinghouse "design firsts" include radial-flow, air ejectors, steel diaphragms for tube expansion, vertical propeller pumps and reverse flow valves.

Because of its vast and continuing research projects, Westinghouse has been traditionally *first* with design improvements. That's why it pays to specify Westinghouse. *You get today... the surface condenser of tomorrow.*

For complete information, contact your Westinghouse representative, or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-50608

Research developments now underway

Through Plowback of Earnings into research, Westinghouse is pioneering many condenser developments that will do much to help the industry meet future loads with low-cost electricity. Following are a few of the projects that are underway in the $6,000,000 Westinghouse Steam Development Laboratory.

Lower costs for foundations

Westinghouse research and development engineers are exploring new structural designs that promise to slash the weight and size of surface condensers and result in lower costs for foundations.

Dropwise condensation for improved heat transfer

If tube surface were nonwettable, steam would condense as droplets, rather than as a heat-barrier film. Westinghouse is searching for the water repellent that will keep the tubes nonwettable *throughout the life of the condenser*. This research project will result in improved heat transfer rates . . . and permit a great reduction in the size, weight and cost of condensers.

Reduction of aerodynamic losses

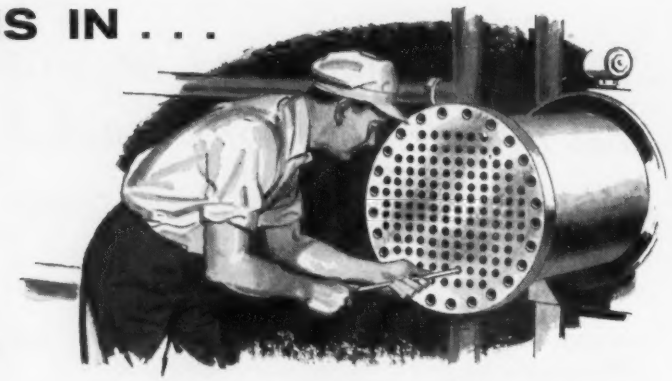
Westinghouse engineers are probing all the interrelated causes of aerodynamic losses in the transition section between the turbine and the condenser. These studies, made in cooperation with the turbine department, are leading to design changes that will give the industry condensers that are not only smaller, but more efficient.

Greater velocity for increased efficiency

The greater the water velocity, the better the heat transfer rate. Also true — the greater the velocity, the shorter the life of the tubes. In the Westinghouse Steam Development Laboratory, engineers are busy studying ways to prolong the life of tubes subjected to water velocities greater than the present seven to eight feet per second.

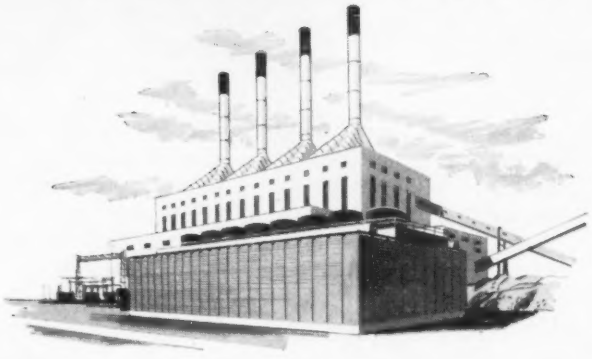
YOU CAN BE SURE...IF IT'S **Westinghouse**

WATER PROBLEMS IN . . .



heat exchangers?

pipe lines?



cooling towers?

CALGON HAS THE ANSWER

Corrosion and other water damage to key points in cooling and service water systems can tie up an entire plant. Costly equipment can be damaged beyond repair. Replacement costs and the losses caused by unscheduled outages far outweigh the modest cost of adequate protection.

Call on Calgon Engineering Service to insure protection of the entire system. From cooling towers on through, the Calgon engineer can save you money and time. Experience with every type of water problem in all parts of the country, backed by complete laboratory facilities, is at your service.

Corrosion control with Calgon* is only one of the many services available. A letter or phone call will bring a man with the water problem answers to work for you.

*Calgon is the Registered Trademark of Calgon Company for its sodium phosphate glass (sodium hexametaphosphate) products. The use of polyphosphates for the prevention of corrosion is covered by U. S. Patent 2,337,856.

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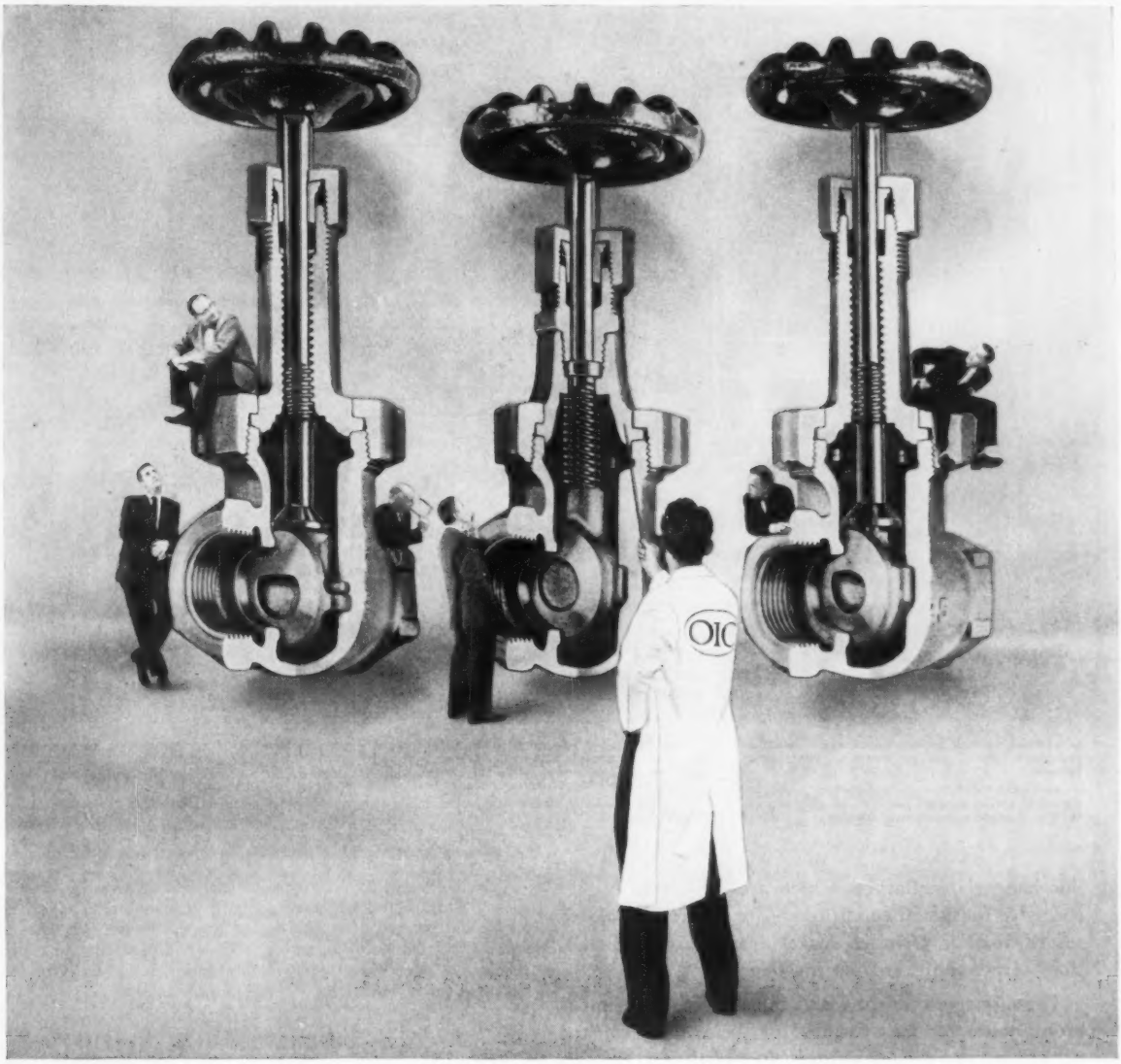
...3 gate valve types in 3 pressure classes, gentlemen, all with safe, efficient (and effective) union ring joints



125 lb.—150 lb.—200 lb. OIC bronze gates . . . the most *modern*, complete line you'll find anywhere. Solid wedge—split wedge—rising or non-rising stems. All, of course, featuring OIC *alloy-40* stems which OUTLAST ORDINARY VALVE STEMS 10 to 1!

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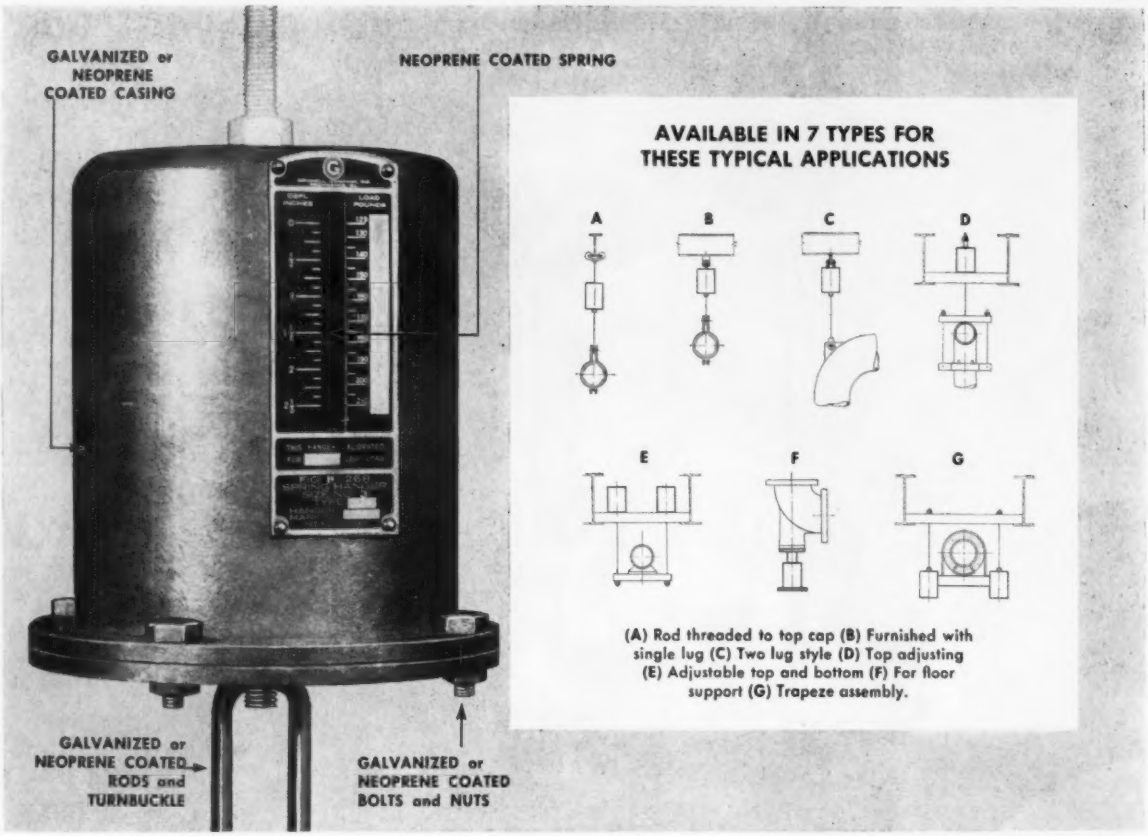
corrosion-resistant, weather-resistant

GRINNELL VARIABLE SPRING HANGERS


GALVANIZED or NEOPRENE COATED CASING
NEOPRENE COATED SPRING
GALVANIZED or NEOPRENE COATED RODS and TURNBUCKLE
GALVANIZED or NEOPRENE COATED BOLTS and NUTS
AVAILABLE IN 7 TYPES FOR THESE TYPICAL APPLICATIONS
A
B
C
D
E
F
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(A) Rod threaded to top cap (B) Furnished with single lug (C) Two lug style (D) Top adjusting (E) Adjustable top and bottom (F) For floor support (G) Trapeze assembly.

In addition to their proven corrosion and weather resistance, these spring hangers offer other features.

- Maximum variation in supporting force for standard spring models per ½" of deflection is 10½% of rated capacity — in all sizes.
- Precompression (a patented feature) assures operation of spring within its proper working range, as well as saving valuable erection time. Reduced over-all height saves space.
- 21 sizes available from stock for load ranges from 50 lbs. to 28,200 lbs.
- Available in 3 spring lengths for maximum travel of 1¼, 2½, and 5 inches.
- Installation simplified by integral load scale and travel indicators.
- All-steel welded construction meets pressure piping code.

For hanger installations which are subject to highly corrosive industrial conditions — or where exposed to severe weather, Grinnell makes available two distinct lines of pre-engineered spring hangers.

These hangers are the result of extensive experimentation with various coatings for Grinnell's standard pre-engineered spring hangers. In addition to providing flexibility in pipe suspension, they provide versatility of application through their corrosion-resistant characteristics.

1. NEOPRENE COATED – for highly corrosive conditions, such as those found in chemical plants and refineries. All parts of the hanger are neoprene coated to protect the base metal from a wide range of corrosives. The flex life of the spring is unaffected by the neoprene . . . the coating resists cracking or flaking over a wide temperature range.

2. GALVANIZED – for outdoor installations, where weather conditions are severe. All parts of the hanger are galvanized except the spring, which is neoprene coated to avoid alterations of temper, hydrogen embrittlement and decreased flex-life of the spring — usual hazards to springs from the galvanizing process. Write for further details.

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

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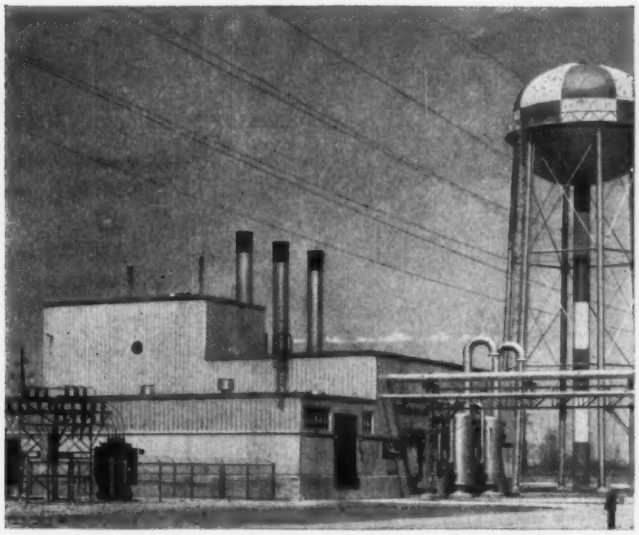
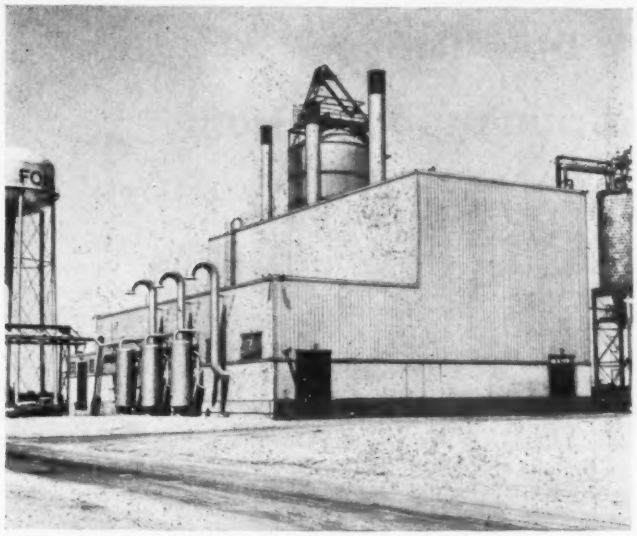
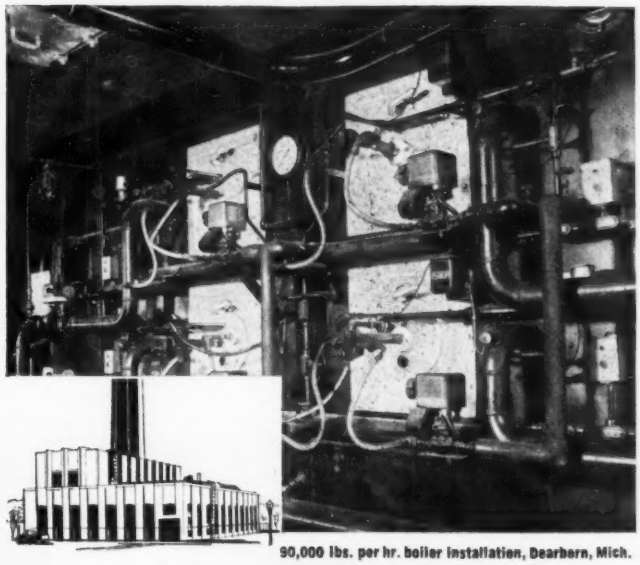


Steam and compressed air plant, Rawsonville, Michigan. Total capacity: 120,000 lbs. per hr.



Steam and compressed air plant, Indianapolis. Total capacity: 300,000 lbs. per hr.



90,000 lbs. per hr. boiler installation, Dearborn, Mich.

FORD POWERS UP with Pritchard-built power plants

What's the most important factor in an industrial power plant? Efficiency? Low investment cost?

The Ford Motor Co. will tell you it's neither factor—when considered separately. The highly efficient plant may have cost so much to build that its products—steam and air—are too expensive for the highly competitive automobile manufacturing business. On the other hand, the low cost plant may never operate efficiently and may be subject to frequent break-downs.

The first power plant built for Ford by J. F. Pritchard & Co. has shown a favorable operating cost-investment cost ratio. Since then, two more Ford power construction jobs have been completed by Pritchard.

Balancing investment costs with operating costs is basic to Pritchard's approach to power plant construction. This requires more than engineering skill alone—more than good construction—more than careful purchasing and coordination. It combines these factors in such a way that the completed plant costs least to own and operate in the long run.

If you are considering expansion or new construction, assign the job to Pritchard. Our services range from economic surveys to completion of turn-key jobs . . . our experience from the construction of industrial power plants to central stations.

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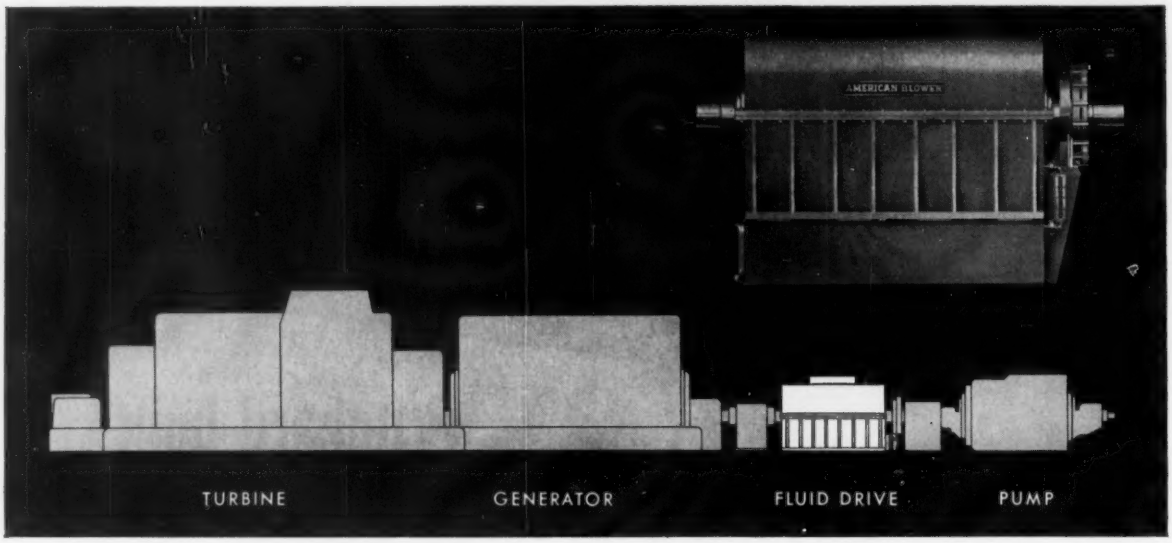
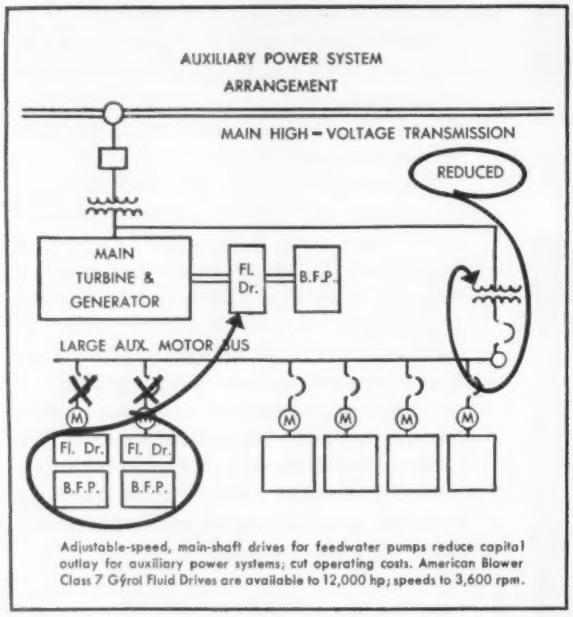


American Blower *Gýrol*® Fluid Drive lets you:

Take boiler feed-pump power from main-turbine shaft . . . slash auxiliary costs!

Save price of motors, switchgear, conduit and cable. Release more power to consumer lines. Reduce operating costs.



Adjustable-speed, main-shaft drives for feedwater pumps reduce capital outlay for auxiliary power systems; cut operating costs. American Blower Class 7 Gýrol Fluid Drives are available to 12,000 hp; speeds to 3,600 rpm.

Savings of nearly $500,000 are predicted for two new 290-Mw units scheduled for service this year. Both use main-turbine feedwater pumps driven through American Blower adjustable-speed Gýrol Fluid Drives.

Savings are threefold:

1. Shaft-end pumps eliminate costly electrical accessories necessary for motor-driven feed pumps.

2. Auxiliary demands are reduced, so more power can be released to consumer lines.

3. American Blower Gýrol Fluid Drive saves power over the entire operating range. It offers adjustable-speed pump control that eliminates wasteful throttling; reduces wear by operating pumps at speeds to fit boiler demands.

In addition, paralleling of pumps is simplified with Gýrol Fluid Drive. Emergency changeover from operating to standby pump is easily accomplished.

Let an American Blower sales engineer show you how Gýrol Fluid Drive can save power, cut costs . . . improve operating efficiency. Contact our nearest branch office, or write: American-Standard,* American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

*American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
AMERICAN BLOWER DIVISION

USS Skipjack posing momentarily on the ways of its builders, Electric Boat Division of General Dynamics Corporation at Groton, Connecticut.

Modern Felt Insulation by Anchor

Demonstrating exceptional speed and maneuverability the USS Skipjack ushers in an advanced class of atomic powered submarines employing the latest in underwater engineering.

An important design feature of these vessels is the effective use of Ankorite Felt. Ankorite Felt exhibits extremely low sonic and thermal conductivity. Whether in full rolls 36" wide and 100 or more feet in length, gasket form or as adhesive backed tapes, they are pressure sensitive and easy to apply in any position. Ankorite Felts are water-proof, fire resistant, non-oxidizing, and non-toxic.

So wherever vibration, noise, moisture, corrosion, dust or grit is a problem, specify Ankorite Felt Gasketing or Tape. There is an Ankorite impregnated felt tape or gasket for every industrial use. Contact your Anchor representative today.

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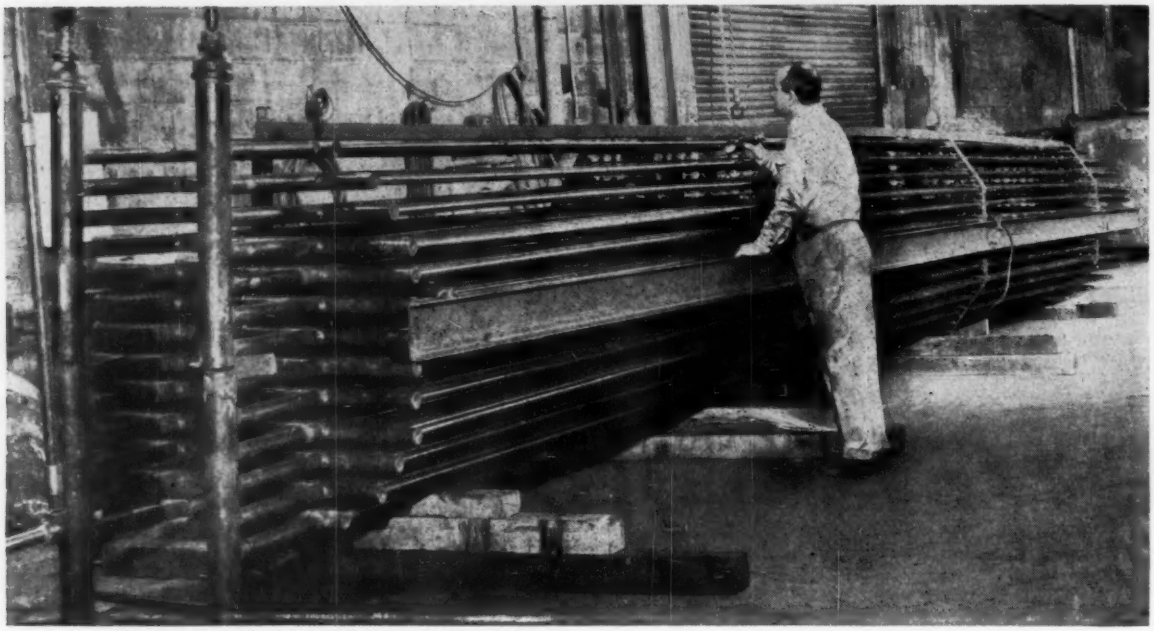

Pipe fabricators: Cornell & Underhill, Inc., Hoboken, N. J.

During fabrication, the USS* NATIONAL Seamless Steel Tubes used in this 8-ton heat exchanger were turned, or bent, 193 times! What's more, fabrication involved 584 pipe welds of various types and 1,720 inches of fillet welding. Mainly, the 35-foot-long, 5-foot-high bundle consists of ¾-inch Schedule 80 NATIONAL* Seamless Pressure Tubes; fabricated for the Solvay Process Division of Allied Chemical & Dye Corporation.

NATIONAL Seamless Pipe and Tubes are known the world over for safety and dependability. They are available in carbon through the various alloy and stainless grades. Get the complete story by sending for Bulletins 10 and 26. And, for technical assistance, our Mill Service Force is available for field consultation. Write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

"The world's largest and most experienced manufacturer of tubular products—NATIONAL TUBE"

National Tube Division of USS United States Steel

*TRADEMARK

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors · United States Steel Supply Division
United States Steel Export Company, New York

"Used many makes of turbines... PREFERS COPPUS"

If you want to know about turbine performance, ask an *operator*. He *knows*. And, in the words of one of them:

> "I have had occasion in the past to operate many makes of turbines. The plant in which I am now employed is almost entirely Coppus equipped on our auxiliary equipment. I find your turbines most satisfactory and would like to congratulate you on your design."

Whether you use a Coppus with a regular wheel or wide bucket "L" type you get these *proven* features:

- Turbines rated close to your hp requirements from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.
- Coppus Steam Turbines ranging from 150 hp down to fractional in 6 frame sizes, *make turbine dollars go farther*. Send for Bulletin 135 on Coppus Turbine.

COPPUS ENGINEERING CORPORATION
171 Park Avenue, Worcester 2, Mass.
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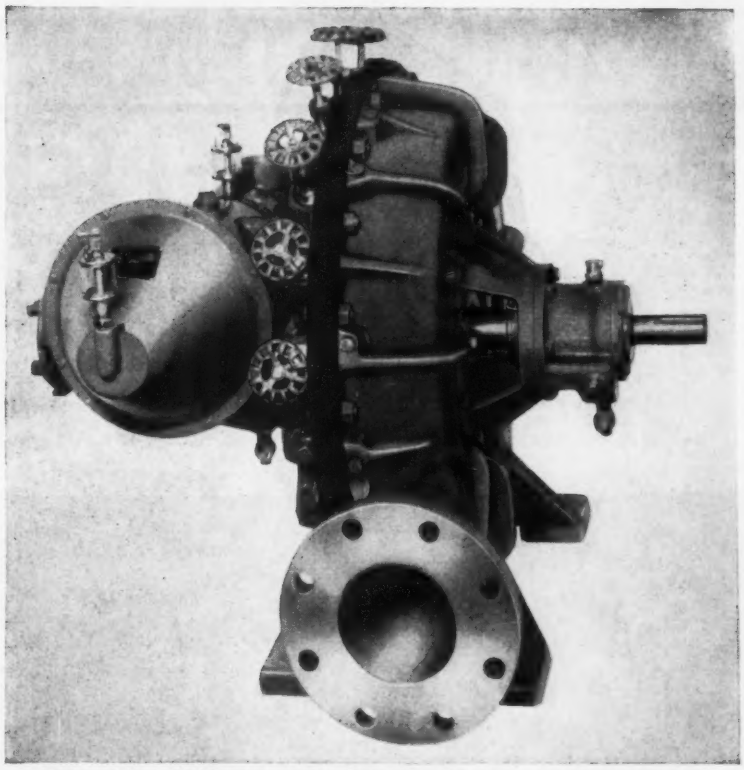

This is the reliable Coppus Turbine furnished with either a regular wheel or wide bucket "L" type wheel.

This wide bucket "L" type wheel is a new development for use where low water rate is essential

This is the regular wheel used on Coppus Turbines which have been so highly satisfactory throughout industry.

COPPUS "BLUE RIBBON" TURBINES

IT STICKS TO HOT OR COLD SURFACES!

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- Because it sticks, Super "66" saves time—applies quickly to any equipment, cold or hot! Effective up to 1800 F.
- Because it sticks, Super "66" saves money—provides far greater coverage and more efficient insulation.
- Because it sticks, Super "66" makes difficult jobs easy—can be used on irregular shapes where application of other insulations is often impossible. Usually requires no reinforcing on applications up to 1½ inches thick.
- Unique "springy ball" structure of small, resilient mineral wool pellets results in maximum efficiency—maximum fuel savings!
- Super "66" contains a special rust inhibitive which actually prevents corrosion!

Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.

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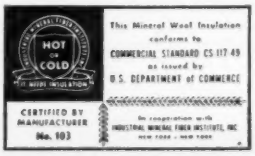

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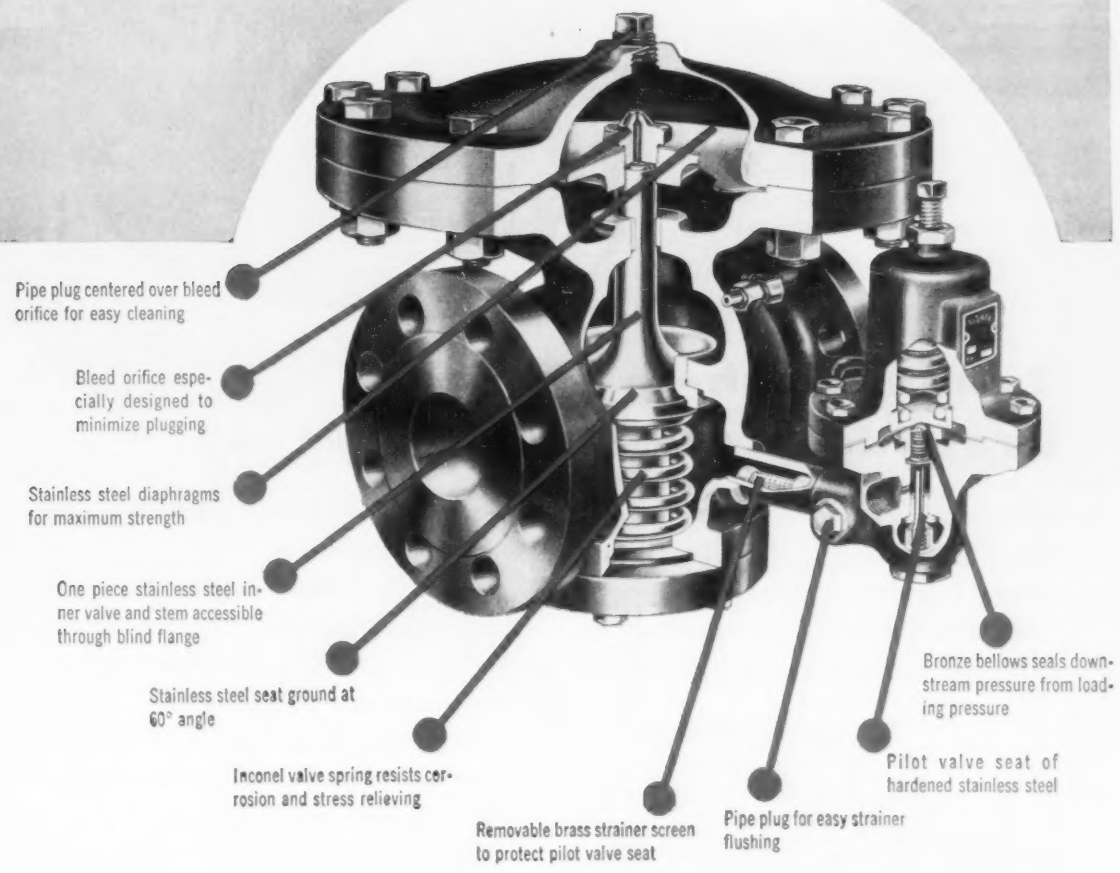
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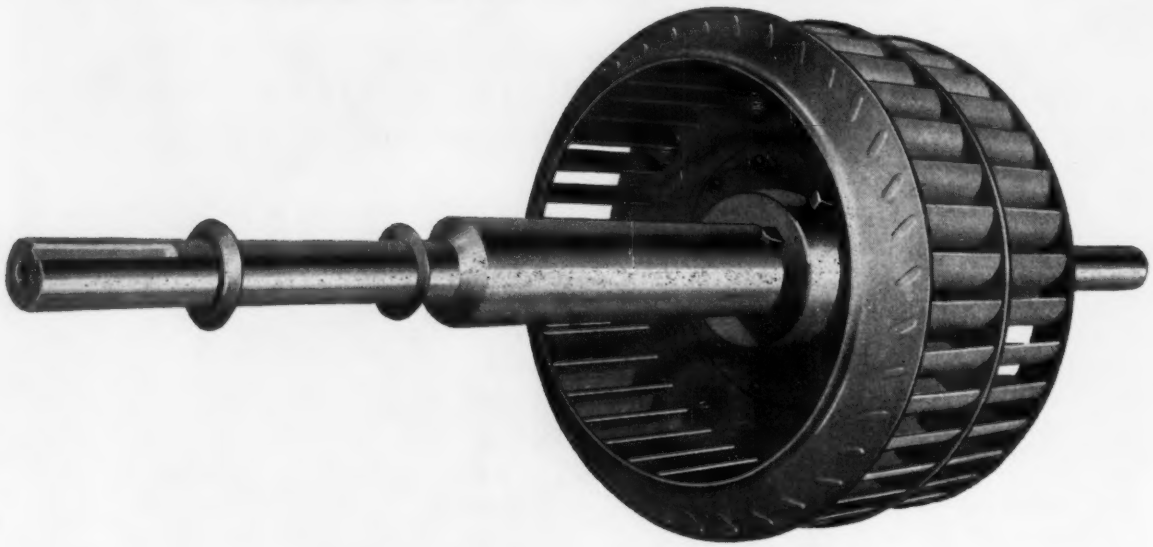

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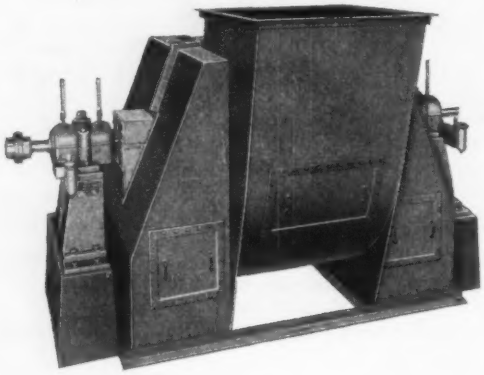

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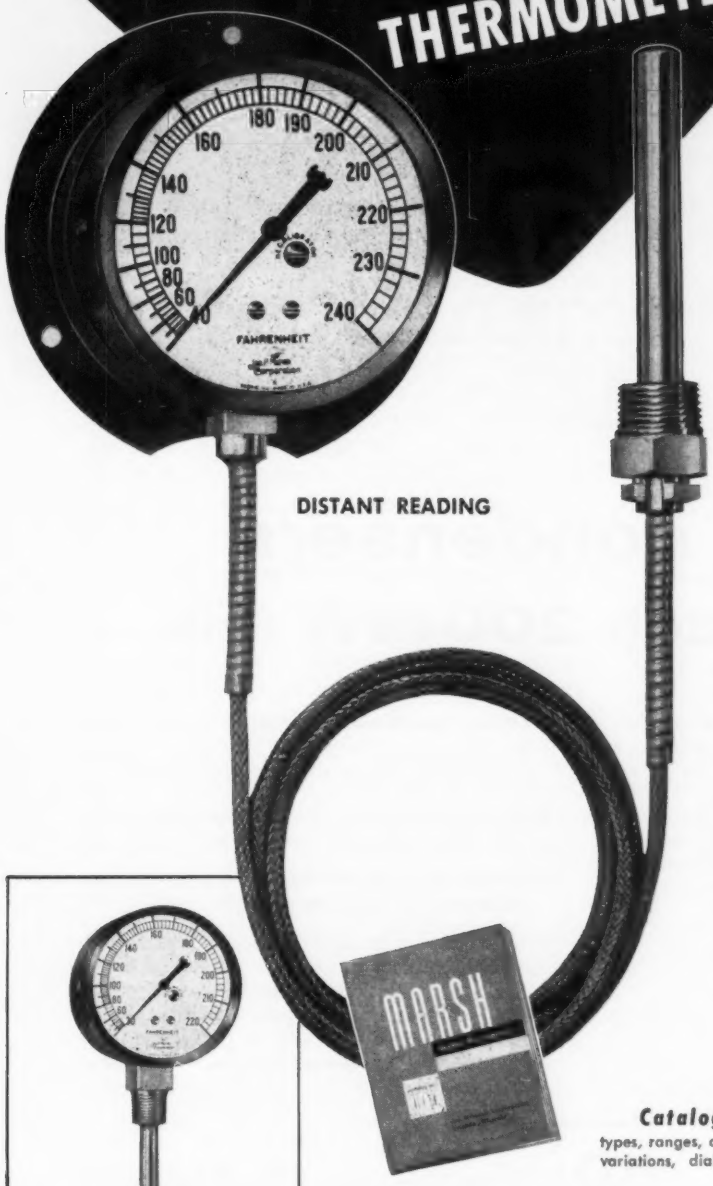

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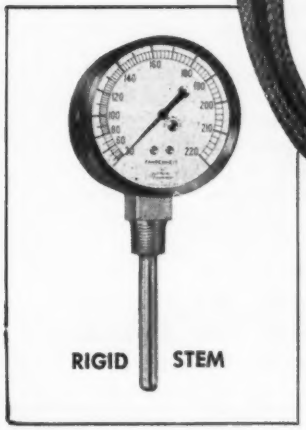

Catalog covers all details—
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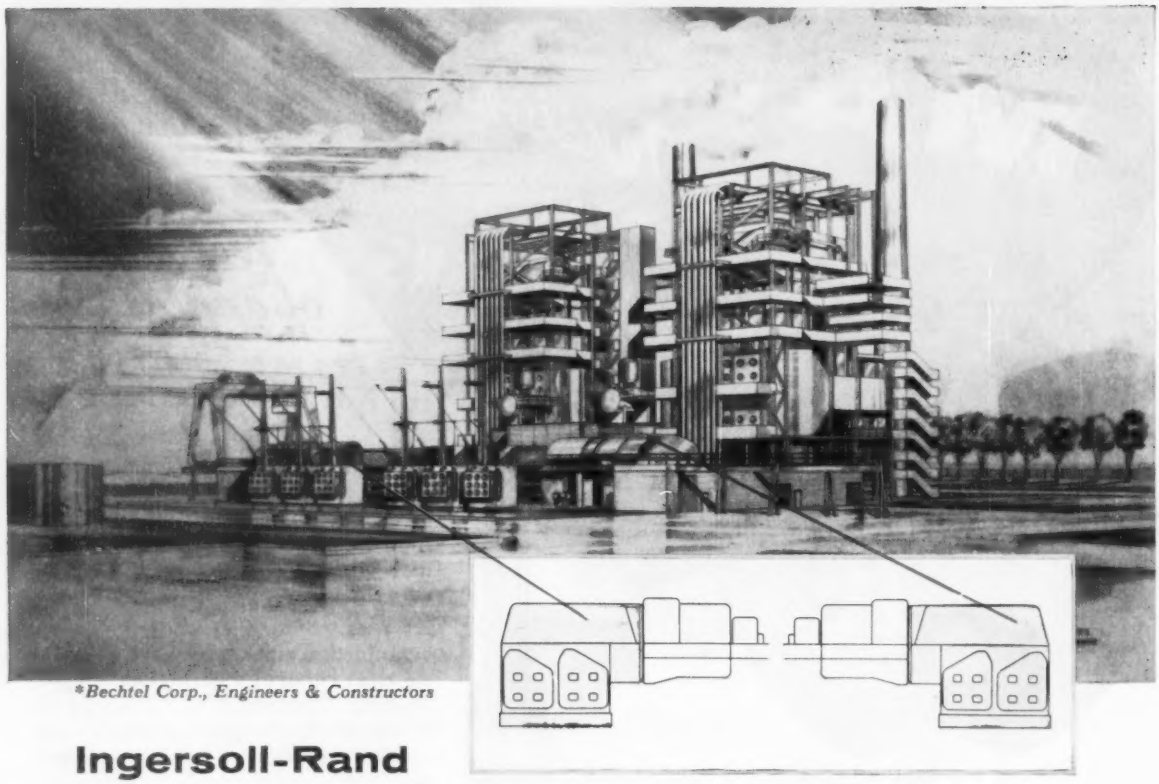
For Southern California Edison Company's
new Huntington Beach Steam Station*...



*Bechtel Corp., Engineers & Constructors

Ingersoll-Rand

axial-inlet condensers will serve each 200 MW unit

Designed for an eventual four units, the first two units of the new Huntington Beach Steam Station are now under construction. Turbines are cross-compound axial exhaust, 2400 psig., 1050°/1000°, 3600/1800 rpm. As indicated above in the artist's rendering, these units will be served by axial-inlet condensers, specially designed for this installation by Ingersoll-Rand. These I-R condensers are 2-pass units, each with 110,000 sq ft of surface.

In addition to the surface condensers, Ingersoll-Rand is furnishing the following associated equipment:

5 boiler-feed pumps rated 2020 gpm at 6400 ft TDH.

4 vertical condensate pumps, 3-stage, rated 2500 gpm at 350 ft TDH.

5 condensate booster pumps, rated 1851 gpm at 1970 ft TDH.

4 vertical condenser circulating pumps, rated 44,000 gpm at 35 ft TDH. The columns and discharge head sections are lined with Fiberglas.

2 steam-jet ejector units, 2-stage, single-element with surface-type inter and after condensers.

2 horizontal reciprocating vacuum pumps each driven by a 100 hp electric motor.

This installation is another dramatic example of Ingersoll-Rand's ability to meet the requirements of the modern steam plant... with advanced design surface condensers, pumps and associated equipment. Your I-R engineer will be glad to help you determine the equipment best suited to *your* requirements.

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LOUIS N ROWLEY, EDITOR • NOVEMBER 1958 • ESTABLISHED 1882 Power

More about "boiler hp"

On this page in the August issue, I urged concerted action to kill the term "boiler hp" and to adopt a common standard for measuring output, preferably "lb per hr".

As you might expect, that editorial drew considerable comment, and the roundup on p 93 gives an idea of the varying points of view. These break down into three broad groups: (1) those who favor replacing "boiler hp" with "lb per hr" (2) those who believe "boiler hp" should be retained and (3) those who would substitute for "boiler hp" something other than "lb per hr".

It is also evident from the comments that the way in which boiler ratings are determined is also a matter that needs further clarification. I'd like to come back to that in a later issue; right now, let's concentrate on the units by which we measure boiler output.

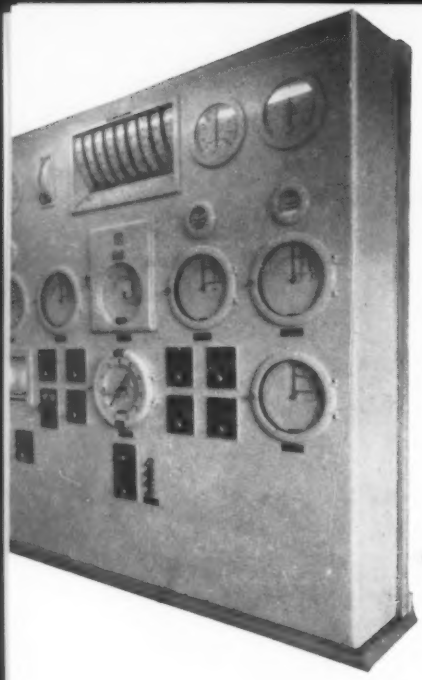
In the discussion beginning on p 93, continued use of "boiler hp" is defended on two main grounds. In the first place, it is the most familiar and meaningful term for many boiler buyers, particularly purchasers of small units. Re-educating these customers and prospects would clearly be a big and tough job. But the longer we wait, the bigger and tougher it will get. If a change will result in long-run improvement, then the sooner we start the better.

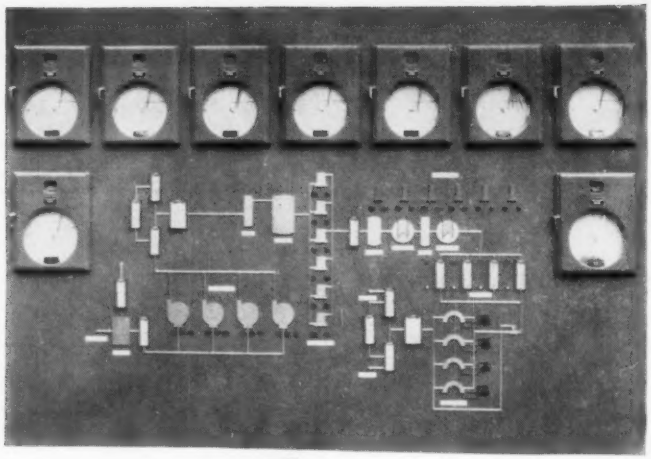
Regardless of habit or custom, other engineers speak up for "boiler hp" on its own merits. It is, they point out, a perfectly definite unit, equivalent to a specified number of Btu per hr. And unlike "lb per hr", it requires no accompanying statement of the steam and feedwater conditions.

And this is where we come to the third of the points of view mentioned earlier—the idea that we should kill "boiler hp" but substitute for it the truly fundamental unit "Btu per hr". The proponents of this measure of capacity make a very persuasive case. In addition to the fact that all other units of measurement really trace back to the basic "Btu per hr", this unit is highly flexible. Many types of loads are commonly figured in Btu and all can be readily converted to Btu. Furthermore, it applies to hot-water and thermal-liquid units as well as to steam generators.

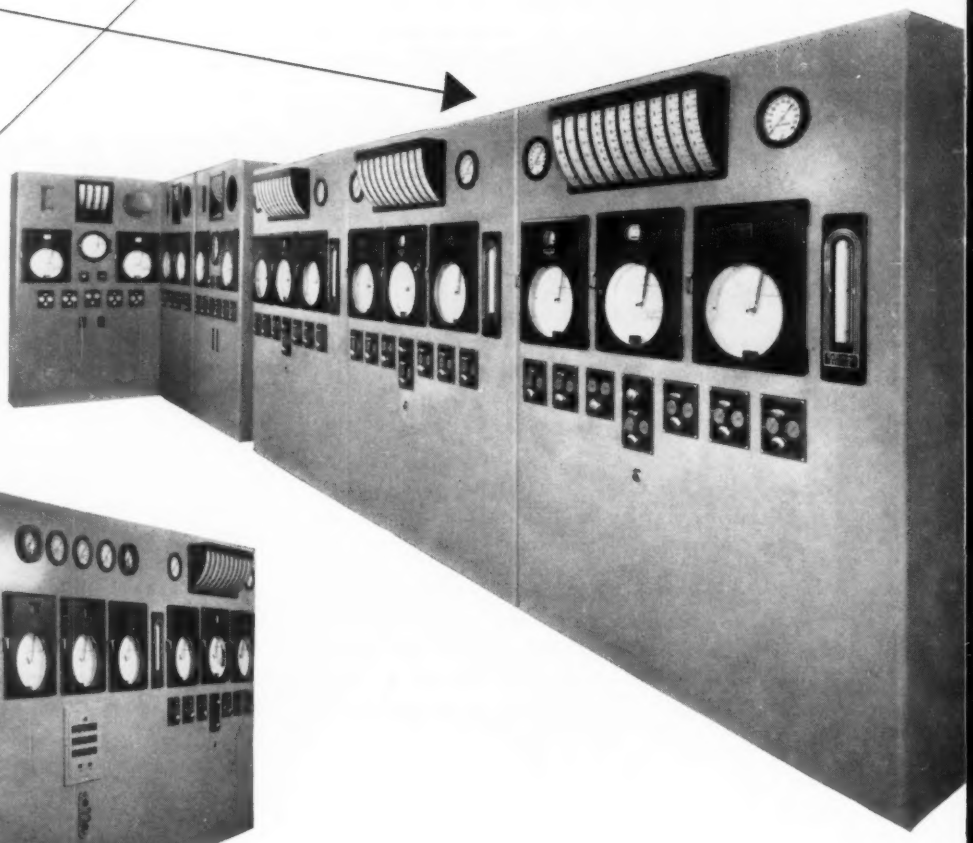
Against "Btu per hr" it might be argued that this represents a nearly complete break with well established custom—a departure for those who now think in terms of "lb per hr" as well as for those who think in "boiler hp". Yet if we take the position, as I believe we should, that habit should not stand in the way of progress, then we cannot, in logic, accept this argument.

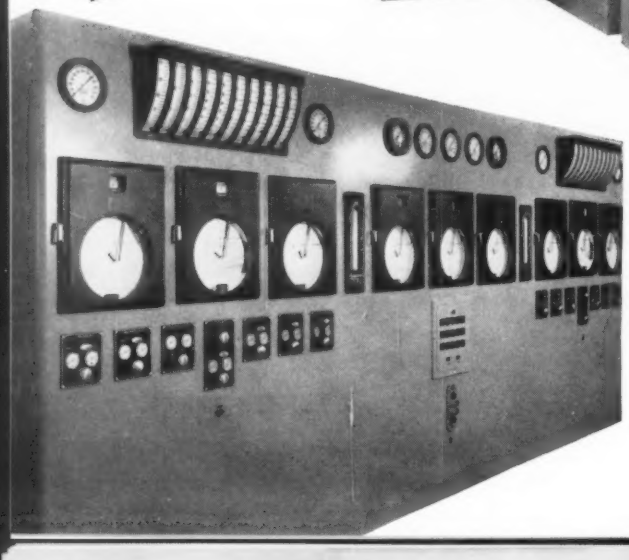
Even a cursory review of the thinking on this problem, as revealed by the published comments, indicates valid reasons for differences and need for utmost care in balancing the various considerations. Certainly, progress has been made in clarifying the matter of boiler-output measurements and I do not believe I am indulging in wishful thinking when I sense a feeling that all interested parties would welcome a satisfactory common standard. We on POWER urge that continuing serious study be given to this problem and pledge ourselves to further the work in all appropriate ways.

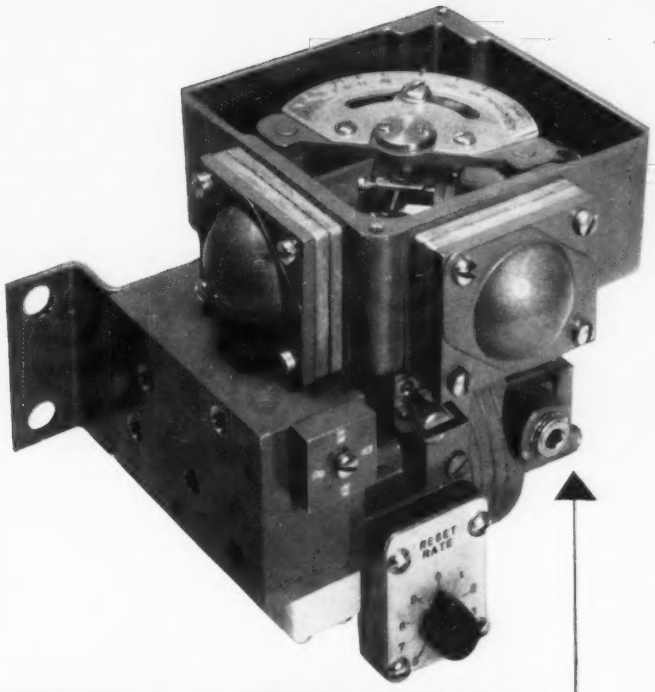




Base Any Of These....







ON THIS

For accurate, efficient, dependable control systems— new Rockwell-Built REPUBLIC TYPE "VC" PNEUMATIC CONTROLLER

Here is an all purpose null-balance-vector controller for use with any pneumatic transmitter. Its proportional band ranges from 2% to 500% *without changing parts*, for quick adaptation to changes in process requirements. Especially important in high-precision control, Republic's Type VC has exceptional sensitivity and a narrow dead band (less than 0.05%). Its high capacity non-bleed pneumatic amplifier consumes little air, keeps output ample. A selector block permits reverse or direct action. Local or remote pneumatic set point optional.

Companion instruments—using an identical null-balance-vector "heart"—include differential pressure, temperature and pressure transmitters . . . ratio, totalizing, multiplying, squaring and square - root - extracting relays. Many parts are interchangeable among the instruments in this "family". Besides reducing spare parts inventory, the similarity of components simplifies the task of training personnel.

Let a Republic engineer show you how these instruments can help to achieve accurate, efficient, dependable control systems. Sales offices in principal cities throughout the U.S. and Canada. Write to Republic Flow Meters Company (subsidiary of Rockwell Manufacturing Company), 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Canada, Ltd., Toronto.

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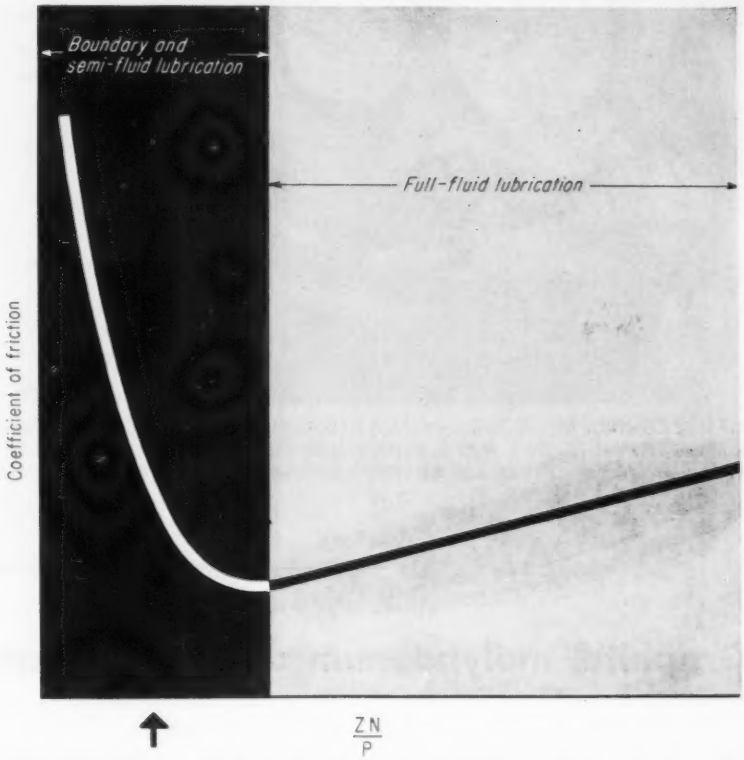
Design and equipment application section

B G A SKROTZKI
Associate Editor in Charge



Solid lubricants . . .

show new promise as additives, dry films, bonded coatings. Lubrication engineers are scrutinizing the labor-saving possibilities if relube time can be stretched. And the never ending search for lifetime lubricants has machine designers taking a fresh look at the solids

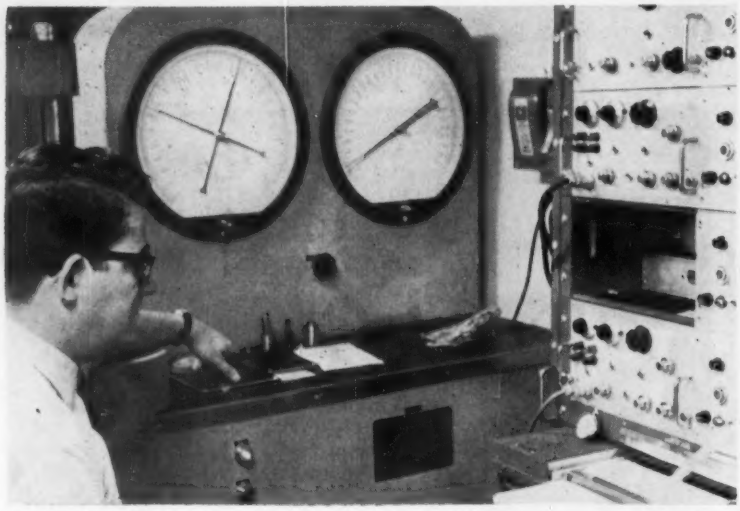
By J J O'CONNOR
Managing Editor

Take a close look at the simple curve shown above. As one of the classics in lubrication engineering it relates lubricant viscosity Z, shaft speed N, nominal pressure P, to coefficient of friction. More important for our immediate purposes, it graphically flags the big market for solid lubricants which is right in the semi-fluid and boundary lubrication region.

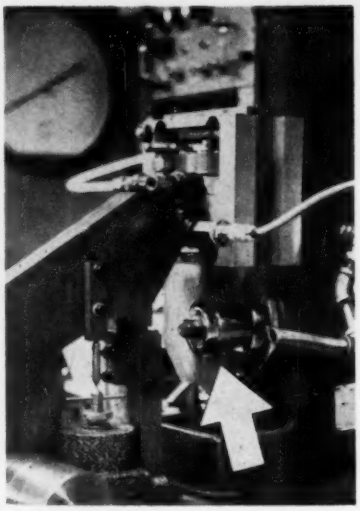
Theoretically, true hydrodynamic lubrication involves no wear and only fluid friction. Yet a solid lube offers little value if it simply floats in a full-fluid film. In everyday practice it's tough to avoid some piercing of the oil film, even in the full-fluid area. Reasoning is based on a shaft, at times, shifting out of its hydrodynamic equilibrium to cut through the oil film and make metal-to-metal kissing contact.

Turn page ►

These laboratory tests indicate a solid lube with top EP qualities



MASTER CONTROL for test machines, located in Alpha Molykote labs, simplifies changing load and speed at specimen. With hydraulic control, load variations from 1 to 1000 lb (as measured through a strain gage transducer) are made with the test machine running



MODIFIED TIMKEN specimens are used to get accuracy and top reproducibility for all types of modern bearing materials

Graphite, molybdenum disulfide, plastics are a few of the

Dry friction, that is, friction measured at surfaces in the absence of lubricant, involves fundamentals that should be clearly understood to better appreciate the role of the solid lubricant. And start by agreeing that it's a difficult matter to make surfaces really flat. Compared to the size of a molecule, hills and valleys in a well-polished metal surface loom large. So when two metal surfaces come in contact, the hilltops of the lower member will offer the real support while being surrounded with relatively large empty areas.

Metal surfaces in contact transmit load on but a few pointed areas. Extent of this area can be determined from electrical resistance measurements. However a practical estimate would put the real area of contact at about one-ten-thousandth of total apparent area.

When the surfaces are forced together some welding results. If one surface is moved over the other those welded junctions are sheared, new ones created and sheared, while mutual plowing takes place. All this leads to the point we are making: that friction force is the force needed to do the weld-shearing and plowing plus lifting of the interlocking asperities over each other. Now we're ready to look at solid lubricants.

Solid lube has been well-defined as a solid material placed between two moving surfaces to prevent metal-to-metal contact, thus reduce friction and wear. We are excluding any EP materials which depend on chemical reaction with the metal for their operation.

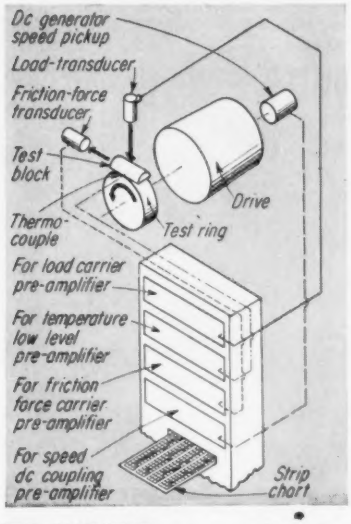
The materials you hear most about these days are graphite, molybdenum disulfide. Remember these are but two of a host of solid lubricants. But they do possess a layer-like construction with the bonding force between layers quite low. Plastics, too, have entered the solid-lube field.

Graphite in its natural form is commercially available as a colloidal suspension in oil. As marketed by Joseph Dixon Crucible Co, it contains 10% by weight of highly purified natural graphite with particle size so minute that resulting blends are claimed to stay in suspension indefinitely. Dixon boasts of controlled tests giving favorable results even beyond a year of undisturbed shelf life. Product is being proposed by the maker as an additive to chain oils, crankcase oils, assembly and running-in lubes, forging compounds, penetrating oils, glass mold release oils.

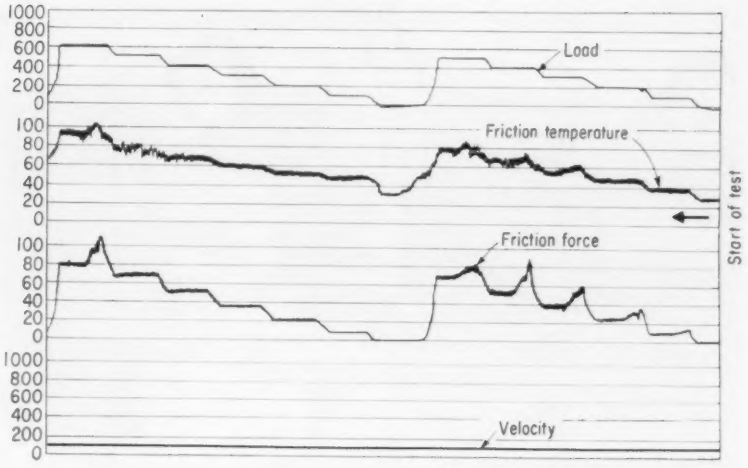
Graphite can also be had in a lubricating product with a paint-like consistency. In most applications it requires only stirring. After applying and air-drying, a dry graphite coating results. Typical uses: coal chutes, elevator guides, winch drums.

Bonded coatings are seeking out an increasing number of applications throughout industry. Whether graphite, molybdenum disulfide, or a combination is used, the crystal structure of low shear strength materials must be held together and bonded to the metal needing lubrication. For more conventional solid-film lubricants the

will shorten the wear-in period while stretching equipment life



TEST VARIABLES are transmitted from transducers through amplifiers to recording unit. Note sample test chart at *right*



TEST RUN DATA shows wear-in using SAE 90 oil with chemical additives. Peaks in friction force and heat, coinciding with load increases, indicate metal working. Using MoS_2 powder, friction force and temperature decreased; working areas within peaks are smaller

many materials being used as modern solid lubricants

bonding may be done with a thermosetting resin. Binders holding the solid lubricant in place are cured by air drying with the aid of a catalyst, or polymerized at some elevated temperature peculiar to the particular binder being used. One of today's more promising bonded coatings contains almost 25% graphite, 75% MoS_2.

Remember, any lubricating bond is solid but quite thin. Its load support must come from the metal to which the film is applied. Although films deform plastically at contact areas, the true contact area is governed to a degree by metal hardness. At least one bonded-coating researcher found wear life of solid film (1) increases as hardness of metal to which the lube is applied (2) decreases with decreasing load (3) increases as surface speeds climb between limits of 0.8 and 24 fpm. Other researchers dispute this latter finding.

Plastics are fast finding their way into the field of solid lubricants and bearings. The attractive frictional properties of polytetrafluoroethylene and the high wear-resistance of nylon partially account for this activity. Under moderate loads and low speeds, polytetrafluoroethylene has appeal as a friction fighter. Nylon is quite durable at high loads and high speeds but when unlubricated may squeak and complain of high friction. Today tetrafluoroethylene (*Teflon* or TFE) resins are finding a growing number of uses.

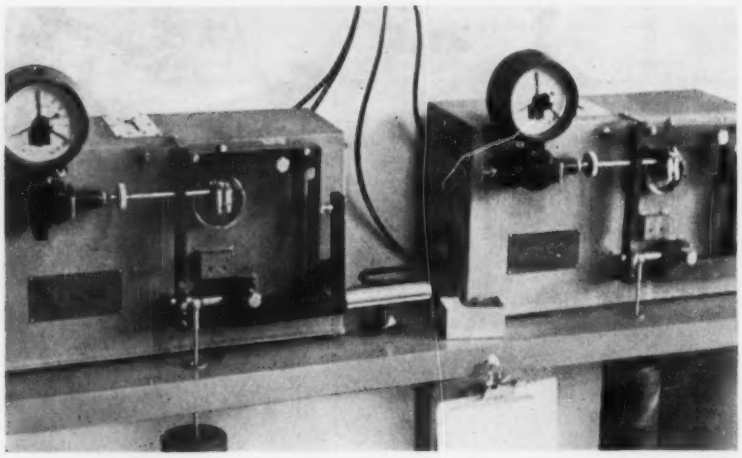
At one time TFE was limited to materials that could withstand the high temperatures necessary for sintering—above 700 F. Recent developments make curing possible at 300 F, even less. So now a lubricating corrosion-resistant film can be applied to wood, rubber, plastics, light metal, other heat-sensitive materials.

Plastic dispersions available from Acheson Colloids Co are made up of specially processed TFE particles suspended in a liquid carrier. During mixing the TFE is slowly added to the binder solution. Result is a smooth dispersion ready for use. Application can be made with a spray gun using 35-50 psi air. This step may be followed by air-drying, infrared or oven curing. Normal film thickness for lubricating purposes is about 0.6 mils. Where thicker coatings are wanted, multiple passes can be made by the spray gun, air-drying between passes. Resulting dispersion combines the low-frictional properties of TFE with durability of the binder. There are many suggested uses for these TFE dispersions with their most interesting properties. Typical: Where load and speeds are favorable such as in fuel injection pumps, conveyors, speedometer cables. Other uses are sure to crop up and, in time, prove themselves.

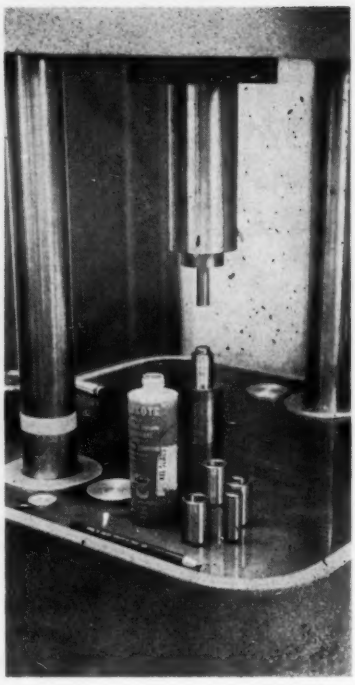
High temperatures, such as met in gas turbines and other aircraft engines, is an area getting serious study within the solid-lubricants framework. However, usefulness of common solid lubricants (graphite and molybdenum disulfide) may be questioned above, say, 850 F. When they reach into that temperature range, serious oxidation is of the lubricant under way.

Turn page ►

EP lab tests coupled with press-fit data pave way for field work



LUBE-FRICTION-WEAR TESTER has a stationary rectangular test block pressed with a predetermined load against a Timken ring. Bearing pressures may range up to 110,000 psi. Dial indicator shows friction while a counter records the revolutions of test specimen



PRESS-FIT-TEST uses a calibrated compression testing machine. Stick-slip condition is readily spotted since it causes chatter noise and friction force fluctuations. Alpha Molykote labs have gathered practical and reliable data on EP lubes using this machine

→

Solid lube researchers are striving for better ways of

One researcher reports lead oxide shows promise at 1000 F. Coefficient of friction was 0.09 for PbO lubricating a cast Inconel slider on an Inconel disk. As temperatures dropped, friction increased until at room temperature the PbO showed a higher friction than would generally be acceptable for a solid lubricant.

Aircraft makers are looking to solid lubricants for the solution of many problems. Their aim is simple: do away with lube supply lines where possible, lubricate for life where practical.

Boron nitride as a solid lubricant got a promising push from the U. S. Bureau of Mines back in 1953 with a published comment . . . "One of the most interesting facts about boron nitride is its resemblance to graphite, the soft crystalline form of carbon. This similarity has been emphasized by the use of such terms as 'white lampblack' and 'white graphite' when referring to boron nitride. The two compounds are similar in crystal structure." But its true usefulness as a solid lube is not yet backed up by lab or field tests.

Molybdenum disulfide in recent years has seen its application framework greatly expanded. What is MoS_2? It's a soft dark-gray compound refined from the mineral molybdenite. Steel alloying takes the major share of the purified mineral. Like graphite it has a layer-lattice crystal structure. The flat laminar structure of MoS_2 crystal, with sulfur atoms facing on each side of the molybdenum atom, is one reason why it exhibits low coefficients of friction under extreme pressure. Sulfur atoms readily adhere to metal surfaces while the low shear strength of the sulfur-to-sulfur bond provides slip planes with a coefficient of friction below 0.05. The action may be compared to a slice of bread buttered on both sides, in contact with another bread slice similarly buttered.

One MoS_2 study now under way centers about a molybdenum blue compound (an oxide of molybdenum) in true solution with mineral oil. At some specific friction temperature, say 400 F, a chemical reaction produces MoS_2 out of the solution which will layer out on the load-bearing metal surfaces.

Fundamental work along these lines is being carried out by Dr G Spengler, professor at the Institute of Technology at Munich and director of basic research for the Alpha Molykote Corp. A similar investigation is being made by Professor George Hugel at the Institute Français du Petrole in Paris. The Institute is jointly sponsored by the French government and the

Alpha's president Sonntag sets a growing pace for MoS_2

Although only 12-yr old, the Alpha Molykote Corp has become a big name in molybdenum disulfide lubricants. The company had its beginning as a spare-time product development urge on the part of two mechanical engineers. Today, Alfred Sonntag is president of Alpha, headquartered in Stamford, Conn. Sonntag has long been identified with the development and manufacture of materials-testing equipment.

In 1942 Sonntag's testing-machine organization started a systematic search for new materials to cope with fretting in highly loaded, high-speed reciprocating equipment. It was this search which led to the development of company's present line of MoS_2 lubricants. The few early disappointing field tests were traced to impurities in MoS_2, a problem long solved.

The company's basic research and development group is located at the Institute of Technology in Munich, Germany. Along with this the firm has a modern laboratory in their Connecticut plant.

application while holding efficiency and cost in line

French petroleum industry, an interesting combination.

According to Alpha's president Alfred Sonntag, this layering-out-of-solution technique may hold promise for use with the phosphate-ester fluids. These latter materials are being used as fire-resistant hydraulic fluids and are under consideration for steam-turbine lubrication (POWER, May 1958, p 73).

Many engineers deep in the F-R turbine lube question are worried about the lubricating ability of phosphate esters in the boundary region—such as met on turbine startup, shutdown. It may well be an area for more study, using phosphate ester lubes as subject.

Early estimate of cost for such a layering-out lubricant pegs the price at about 250% that of a top-quality petroleum oil. Although still in the developmental stage, this project has racked up some 16 man-years of research by Spengler and Hugel.

The MoS_2 researchers are taking a hard look at developing better ways for impregnating bearings. Problem: When MoS_2 is mixed with oil and fed in to a self-lubricating bearing, the bearing metal filters out the solid lube.

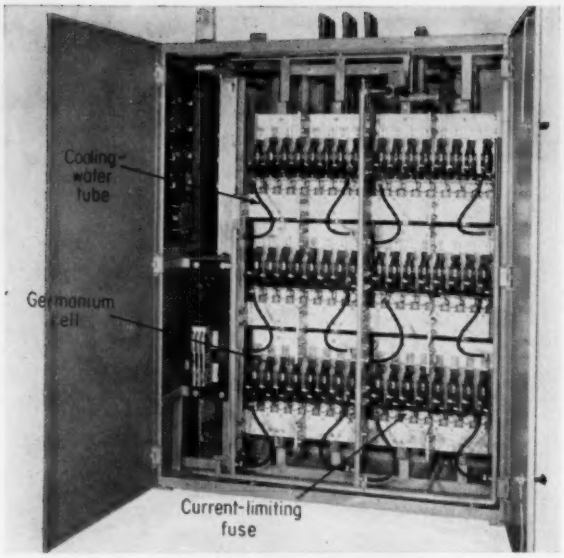
Another solid lubricant technique being scrutinized involves electroplating molybdenum metal onto a metal part. It calls for heating in a sulfur solution, in addition to other steps.

MoS_2 in grease is making news. Right now some of the major oil companies (typical: Gulf, Socony Mobil, Standard of Kentucky) are merchandising an automotive chassis grease containing up to 5% MoS_2 in a top-quality grease. Moly grease has met with some success in the bus and truck fleet field: Success being measured in terms of effective lubrication while stretching the time between lube jobs.

According to Climax Molybdenum, suppliers of molybdenum additive, the MoS_2 films out on metal surfaces while adhering tightly. Lubrication is sustained long after the grease proper has been squeezed or washed out, or wiped away. In the industrial plant, MoS_2 grease will probably find its place as a specialty item; applications where conventional petroleum lubes can't be expected to do a top-flight job without additional lube design provisions. Higher cost of MoS_2 grease will rule out across-the-board use.

Other solid-lube additives in grease have been offered for years by major oil suppliers. Number of solid lubes and lube-binder combinations is growing. In this article we make no attempt to report on *all* solid lubes.

GERMANIUM DIODE is water cooled. It's rated 400 amp, 90 peak operating volts ...



... for units in rectifier package that's rated 8000 amps, 150 volts. Individual diode cells are protected by a current-limiting fuse

Semiconductor rectifiers are ready for

By J L BOYER
Manager, Rectifier Engineering
Westinghouse Electric Corporation

Characteristics of heavy power rectifier loads put severe demands on semiconductor rectifiers. Since it isn't possible to substantially modify the requirements of the loads to match the characteristics of the semiconductors, these needs have had to be met by development of new semiconductor rectifiers. Some problems remain, however, in the use of semiconductor devices.

Many applications of heavy power rectifiers are in a voltage range from 10 to 450 volts. In the past it has been difficult to design rectifiers in this range that had good overall characteristics. Now, with the development of germanium and silicon power rectifiers, rapid progress is being made in the application of these new types of rectifiers in the medium-voltage field.

Large currents supplied at the required voltage for long periods of time is the most important requirement of heavy power rectifiers. It is also desirable to supply this large current without any great change in dc voltage with changing load. This requirement is aided by a low-voltage-regulation power circuit which also tends to make the rectifier more satisfactory for short-time overload ratings. Low-regulation power circuit usually results in a high fault-current rating, and is one of the most important differences between the requirements for semiconductor devices in heavy power applications and the requirements for communication and low-current circuits.

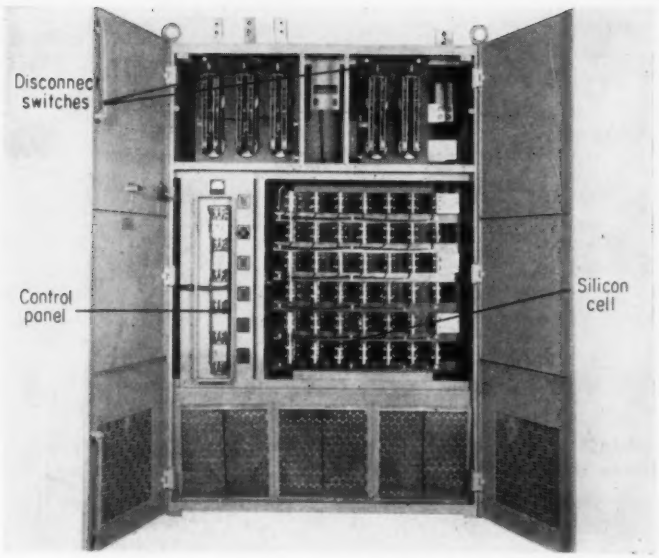
Rated voltage is not the highest voltage that the circuit will have in most heavy power rectifier circuits. There will be small overvoltages that last for relatively long periods of time, and there will be high overvoltages or surges that last for short periods of time. Supply system variations produce slight overvoltages and circuit breaker or fuse operation, arcing on the ac and dc systems, and lightning will produce large overvoltages for a short time. These overvoltages may be two or three times the rated voltage.

Efficiency in all heavy rectifiers is important because the power expense is a large portion of the total cost of the process. In large electrochemical applications, power cost is the most important factor in rectifier selection.

Maintenance downtime is also important since heavy power rectifiers are usually used for long-hour applications, in many cases on a 24-hr basis. Downtime must be considered from the point of view of lost production, expense of replacement parts and man-hours of maintenance.

Every heavy-power rectifier application has some general requirements such as size, cost and power factor. In some cases these can determine the type of rectifier that should be used. Some applications have special requirements such as no cooling water, no cooling air, corrosive air, high ambient temperature or vibration.

SILICON DIODE, cooled by forced air over fins, is rated 200 amps at 180 peak operating volts . . .



. . . for combination in rectifier rated 1250 amps at 540 volts. Disconnecting switches for ac and dc are in top compartments; the control panel is at left.

a bigger chunk of today's dc load

When one of these requirements is unusually difficult to satisfy, it may be necessary to disregard some of the other more basic requirements.

Medium dc voltage field of heavy-power rectifiers has a number of major applications. While most applications call for the same general requirements, each service puts different emphasis on various needs. For this reason, it is necessary to make slightly different equipment designs for various services even in the rather narrow medium-voltage field, as indicated in table on page 85.

In electroplating and anodizing service, characteristics such as efficiency, size, initial investment and maintenance cost are important. In arc-furnace power supplies, the same characteristics are still important but reliability becomes extremely important, and may overshadow some of the other requirements. For medium-voltage electrochemical applications, the efficiency and maintenance cost are the deciding factors. In other cases, there may be special conditions which determine the important required characteristics for power rectifiers.

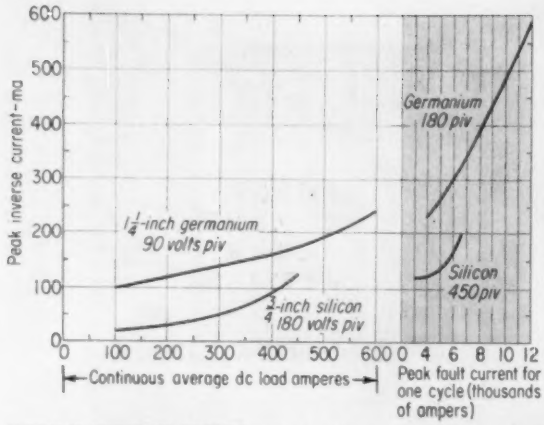
Typical applications that are the largest users of power rectifiers, and a general view of their characteristics, are given in table, p 85.

The power circuit of a typical semiconductor power rectifier is shown at top right of p 84. A double-way circuit is used because the dc voltage called for is higher than can be obtained with a single-way. In each phase diodes are connected in parallel in order to give the desired current rating. Output dc voltage, in this case, is controlled by means of saturating reactors in the ac circuit feeding the rectifier transformer, but other means of voltage control can also be used in most applications.

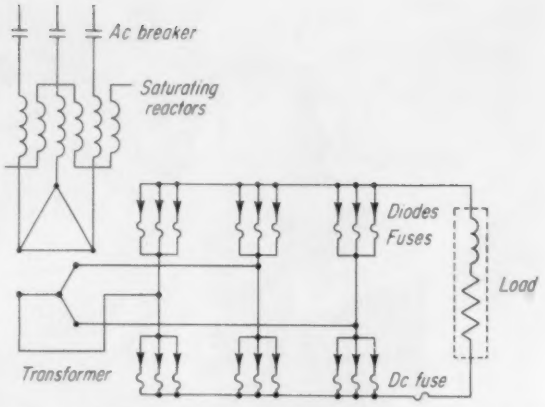
To meet the needs of medium-voltage applications, it is necessary to have semiconductor rectifier elements which have reasonable current and voltage characteristics in order to combine the diodes in a power circuit with the best overall characteristics. It is desirable to obtain an individual element with an average current rating of about 50 to 400 amp with a piv rating on a continuous basis of between 50 to 400 volts, and short-time rating from 200 to 1200 volts. In addition to this, the rectifier elements must be able to carry a very heavy fault current.

Characteristics of a water-cooled germanium diode and an air-cooled silicon diode under normal loading and under fault conditions are shown top left, p 84. Best measure of the conditions in a semiconductor diode is a record of the inverse-leakage current under various operating conditions. To approximate the continuous rating of the diode, plot the inverse leakage current against the load current at the estimated rated inverse voltage. If there were no overloads or overvoltages, load current at which the inverse leakage current starts to rapidly increase should be the continuous load limit.

Actually, continuous rated inverse voltage, load current, overload current, fault current, peak overvoltage and cooling conditions are all interrelated, and ratings must be established as determined by all of these factors

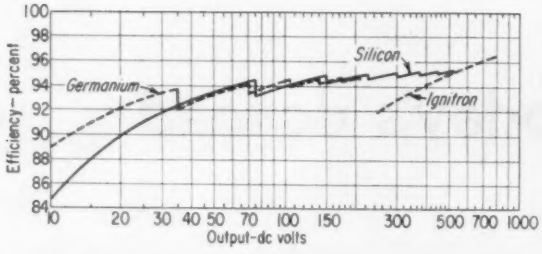


INVERSE-CURRENT CURVES typical of large germanium and silicon diodes under load conditions, corresponding peak fault current

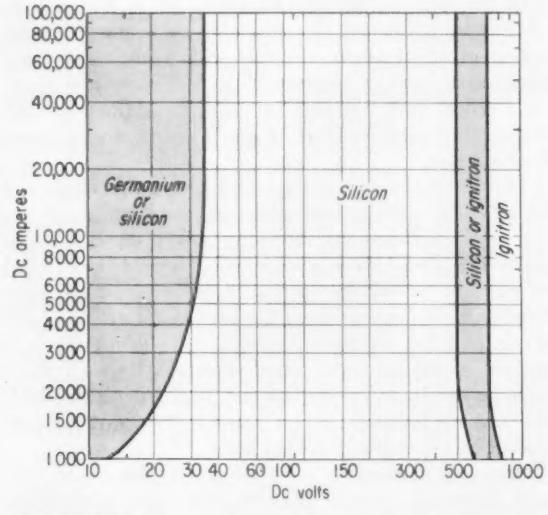


TYPICAL POWER CIRCUIT for semiconductor rectifiers is 2-way type. Three diodes are shown in parallel for this particular unit

Silicon and Germanium cells cover wide range



OVERALL EFFICIENCIES for germanium, silicon and ignitron rectifier units with voltage control. Note wide range of silicon



APPLICATION ranges recommended for germanium, silicon and mercury-arc (ignitron) rectifiers for various currents and voltages

at one time since this is the condition obtained in actual operation. This fact was overlooked in the design of some early semiconductor rectifiers for heavy power applications. Result: many diodes were destroyed due to incorrect rating and application. One can calculate current and voltage ratings of a complete power rectifier from the basic characteristics of the diodes that are used; however, one cannot obtain great accuracy by this method. The most reliable way to set ratings is to run tests with all of the conditions present at one time, and record the inverse current of each diode on an oscillograph. There are variations from one diode to the next diode of the same design; therefore, tests on a number of diodes must be made before any dependable ratings can be established.

Current overload capacity of semiconductor diodes is low because the working mass of a semiconductor diode is extremely small and has very low thermal storage capacity. In other words, the semiconductor diodes tend to be continuously rated devices. Almost all of the overload capacity is obtained by derating the devices at their continuous rating. To some extent this is also true of fault currents that last for one to ten cycles of a 60-cps supply system. A reduction of continuous load current is necessary to carry the high-fault currents.

Overall current capacity of a semiconductor device is determined by its forward-drop characteristics, temperature of junction under normal operation and temperature limits of operation of the semiconductor material used in the device. Current and forward voltage drop determine most of the losses in the device. Operating temperature of the junction and temperature limit sets the thermal differential that can be used to dissipate the losses.

Voltage rating of a semiconductor device is even more complex than the current rating but, to a great extent, the voltage rating tends to be a peak limiting value. This peak limit must not be exceeded for even a

Here are characteristics of typical rectifier loads

Type of service	*Voltage range volts*	*Most important characteristics*	*Other characteristics*	*Ratings*
Electroplating	10 to 36	Initial investment	Size and maintenance	5000 to 20,000 amp
Anodizing	18 to 48	Initial investment	Maintenance	5000 to 80,000 amp
Electrochemical				
(a) Low voltage	65 to 120	Efficiency	Maintenance	5000 to 100,000 amp
(b) Medium voltage	120 to 500	Efficiency	Maintenance	5000 to 100,000 amp
(c) High voltage	500 to 1000	Efficiency	Maintenance	5000 to 100,000 amp
Industrial	125 to 250	Maintenance	Size	100, 150, 200, 300, 500, 750 kw
Mining	275 to 300	Initial investment	Current and voltage capacity	300, 500 kw
Transportation	500 to 750	Reliability	Maintenance	750, 1000, 1500, 2000, 3000 kw
Furnace power supply	45 to 80	Reliability		5000 to 15,000 amp
Extremely high voltage	15,000 to 50,000	Reliability	Size	40,000 v, 20 amp

of low and medium-voltage rectifier needs

short time. The voltage that can be supported is partly dependent on junction temperature and current conducted on the previous half cycle. It turns out that the short time overvoltage after carrying a fault current almost always determines the voltage rating of the semiconductor device, not the continuously applied voltage.

Water-cooled germanium diode characteristics are shown at left center, p 84. The device has a current rating of 400 amp with a continuous piv of 90, and its fault current rating is 15,000 amp for one cycle with 180-volt piv. As can be seen from the inverse leakage current curves, these ratings are extremely conservative to give the reliability needed on heavy power equipment. The forward voltage drop at rated current is less than 0.6 volts.

A germanium rectifier rated 8000 amp, 150 volts is shown on p 82. In this rectifier eight diodes are operated electrically in parallel; their water circuits are operated in series. Each diode has a current-limiting fuse—if diode fails the rectifier can continue operating for a reasonable time before diode must be replaced.

Germanium rectifiers have the most advantages for low-voltage high-current applications since the diodes have an extremely low forward drop and good efficiencies can be obtained. On practical rectifiers the dc voltage per germanium diode is limited to a maximum of about 35 volts. This means the diodes must have a piv rating of about 275 volts on a short-time basis.

Because of the relatively low temperature limit of germanium diodes, water cooling provides a good method of cooling the rectifier elements for large rectifiers. Where water cooling is not desirable, air cooling can be used. It is usually more desirable, however, to go to air-cooled silicon diodes.

Almost any current rating can be obtained by operating diodes in parallel and then connecting the rectifiers in parallel on a bus system. When the diodes are connected in parallel, some care must be taken to see that correct current division is obtained. Germanium diodes need not be connected in series, because silicon diodes are available which have much higher voltage ratings.

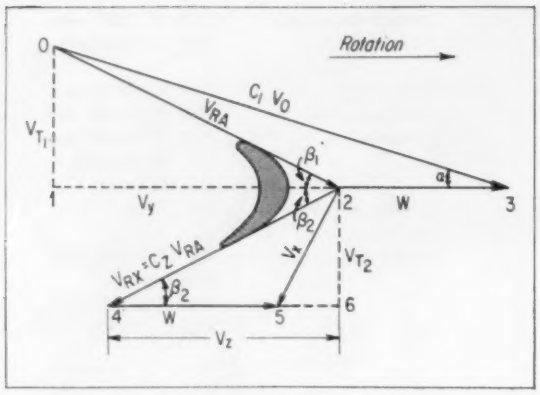
Large silicon diodes have been developed which make it possible to greatly extend the voltage range of semiconductor rectifiers. Silicon diode, shown in photo on p 83, is rated about 200 amp with a continuous piv of 200 volts, and has an instantaneous no-load piv rating of 600 volts. The forward drop at rated current is less than 1.2 volts. The inverse leakage currents of this silicon diode under continuous load and under fault conditions are shown at top left, p 84.

By combining silicon diodes in parallel and in series, it is possible to obtain large rectifier cubicles, photo p 83. This cubicle is one of four in a rectifier installation with a total rating of 5000 amp at 535 volts for the electrolytic reduction of aluminum.

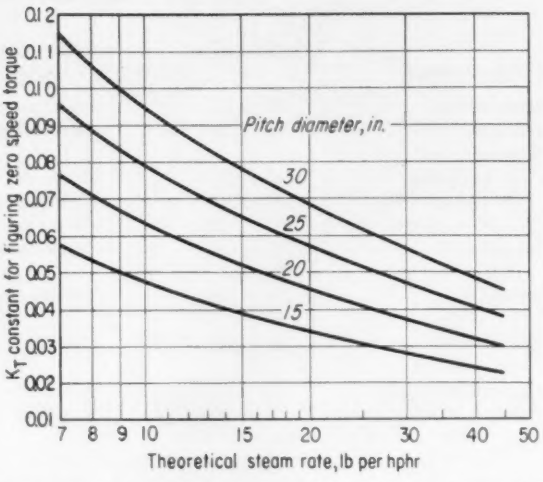
Because of the high voltage limits of silicon diodes, they can be used to obtain practical power rectifiers with dc voltages several times higher than germanium rectifiers. It is usually desirable to have a small resistor in parallel with each silicon diode or group of parallel diodes in order to help keep the inverse voltage divided equally on a series string.

Selection of power rectifier type isn't easy because the many different requirements of the various applications make it impossible to have fixed rules on what type of rectifier should be used in every case. However, for the majority of applications where the most important characteristics are efficiency, first cost, size and maintenance, it is possible to reach some definite application recommendations.

In evaluating efficiency of the various types of power rectifiers, overall efficiencies must be considered because the different types have varying number of components. Larger germanium and silicon rectifiers may have saturating reactors or some other means of voltage control, while in mercury-arc rectifiers *(Continued on page 186)*



1 Velocity diagram for single-row-wheel impulse stage uses typical 11-deg nozzle and 22-deg bucket exit angles for analysis



2 In figuring breakaway torques for single-stage 2-row-wheel impulse stages, constant K_T must be used in formula below

This article starts a series that will explore the innards and applications of mechanical-drive turbines. These versatile prime movers do many jobs at a low energy cost. So let's start by learning . . .

What makes an m-d turbine tick?

By A H SISSON, Manager, Thermodynamic Design, Small Steam Turbine Dept, General Electric Co

Mechanical-drive (m-d) turbines use the same basic principles as the more famous central-station turbine: They both convert some of the energy in steam delivered by a boiler into the kinetic energy of a jet. The steam jets pass over the buckets on a turbine wheel to develop torque on the supporting shaft. The torque turns the shaft and any connected load such as an electric generator, pump or fan.

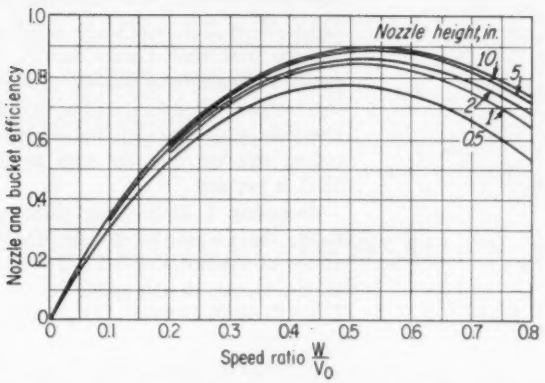
Basic ideas. Before we study how mechanical-drive turbines can be used in various industries (and central stations) let us first review the basic elements of the unit. When we know these elements we'll be ready to study specific uses, later in this series.

Turbine performance centers on the conversion of the steam-jet kinetic energy into mechanical work of the buckets mounted on the turbine wheel. The steam jet gives up its kinetic energy by impacting the buckets which slow it down. The buckets absorb this energy by moving slower than the steam jet and changing direction of the jet travel.

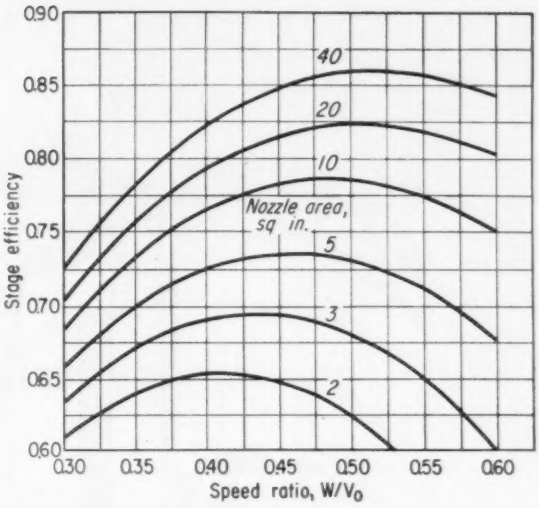
If we can figure the velocity relations and directions of the entering and leaving steam jet and the speed and direction of the buckets, we can predict how a turbine stage will perform. The velocity diagram, Fig. 1, does just this. V_0 is the theoretical speed of the steam jet leaving the turbine-stage nozzle and c_1 the nozzle velocity coefficient. Then the vector c_1V_0 represents direction and actual speed of steam leaving the nozzle.

The bucket center travels at the speed W (wheel speed) at an angle α (alpha) to the jet direction. Both jet and bucket move in relation to the turbine casing, so to find the jet speed referred to the bucket we subtract W from c_1V_0 to find V_{RA} making an angle β_1 (beta) with the bucket travel direction (plane of the wheel). This angle fixes the angle of the face of the bucket receiving the steam jet. The leaving angle β_2 of the bucket roughly equals β_1. In practice the bucket entrance angle may be made a few degrees larger than calculated to avoid hitting the bucket back and generating a retarding force. For a "round nose" bucket edge, entrance angle may equal the theoretical.

With c_2 as the bucket velocity co-



3 Typical nozzle and bucket efficiencies for single-row-wheel impulse turbines reach maximum at certain wheel-steam ratio



4 Typical stage efficiencies for 25-in.-pitch diameter single-row wheel impulse stages vary with nozzle area, speed ratio

efficient we have $V_{RX} = c_2 V_{RA}$ as the speed and direction of the jet leaving the bucket, *relative to the bucket.* To find the actual speed and direction of the exit jet, we subtract the vector W to get V_X.

Resolving V_X and $c_1 V_o$ into two components each, the tangential or whirl velocities are *5-6* and *1-3*. The axial components are *2-6* and *0-1*. Difference of the tangential velocities produce the energy for shaft rotation. Difference of the axial velocities produce a thrust to be controlled by a thrust bearing.

Stage efficiency. We can use Fig. 1 to figure the *diagram nozzle and bucket efficiency* for the turbine stage. As usual, efficiency = output/input. For the stage:

Output = tangential force × distance = $f \times d = m\Delta V \times W$

Input = $mV_o^2/2$

where:

$V_o = \sqrt{2gh} = 223.7\sqrt{E}$ and $E =$ the available energy for stage in Btu per lb of steam.

Collecting terms we get:

$$\text{Efficiency} = \frac{m\Delta V W}{\frac{mV_o^2}{2}} = \frac{2W\Delta V}{V_o^2}$$

where W is in ft per sec; ΔV is change in velocity of the steam relative to the bucket in ft per sec and in the direction of the bucket rotation.

The tangential velocity components which combine to produce shaft power are V_y *and* V_z, and:

$V_y = c_1 V_o \cos a - W$ (A)

$V_z = c_2 V_{RA} \cos\beta_2$ (B)

then $\Delta V = V_y - (-V_z) = V_y + V_z$

$= c_1 V_o \cos a - W + c_2 V_{RA} \cos\beta_2$

Finally:

$$\text{Efficiency} = \frac{2W}{V_o^2}\left(c_1 V_o \cos a - W + c_2 V_{RA}\cos\beta_2\right)$$

$$= \frac{2W}{V_o}\left(c_1 \cos a - \frac{W}{V_o} + C_2 \frac{V_{RA}}{V_o}\cos\beta_2\right)$$

Example: Let's take a turbine stage with $c_1 = 0.97$; $c_2 = 0.84$; $a = 11$ deg; $\beta_2 = 22$ deg, and find the efficiency. Assume that $W/V_o = 0.438$.

V_{RA} must first be found from the vectors V_y and V_{T1}. From equation (A) find $V_y/V_o = 0.515$ and from $V_{T1} = c_1 V_o \sin a$ find that vector $V_{T1} = 0.1853\ V_o$. From the square root of the sum of the squares of these vectors we'll get $V_{RA}/V_o = 0.548$. Substituting in the last equation find the diagram efficiency of 0.824 or 82.4%.

This is a reasonable efficiency for the 0.438 velocity ratio with an impulse stage having a radial nozzle height of 0.75 to 1.00 in. The actual stage efficiency may be considerably lower; it depends on the rating, speed and other details peculiar to the particular turbine.

To get the feel of these figures let's assume that the corrected stage efficiency, e, is 0.70 and the energy $E =$ 44.8 Btu per lb to produce velocity V_o. Then if the steam flow F is 25,000 lb per hr and shaft speed is 6000 rpm, the stage *wheel horsepower* is:

$$WHP = FeE/2544 = 25{,}000 \times 0.70 \times 44.8/2544 = 308$$

A reasonable *friction loss* would be 8 hp, then the *shaft horsepower* is:

$SHP = 308 - 8 = 300$ at the coupling.

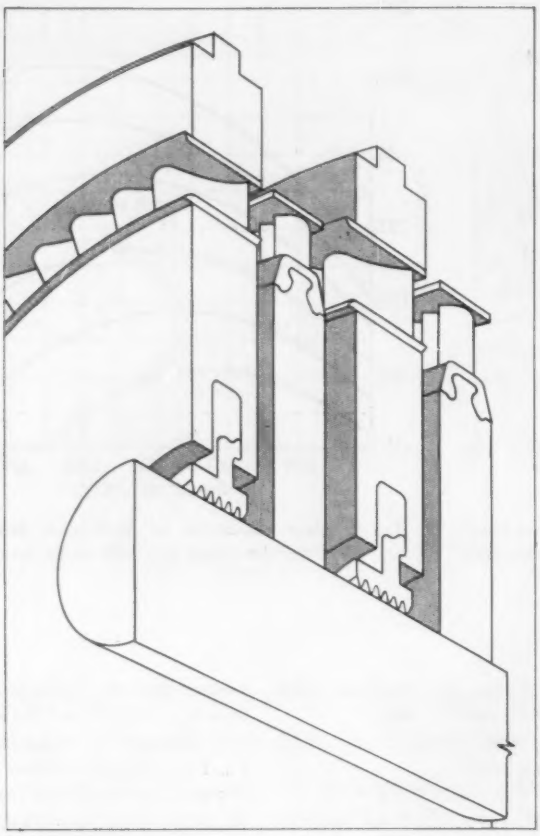
The turbine steam rate is:

$SR = 25{,}000/300 = 83.3$ lb per hphr

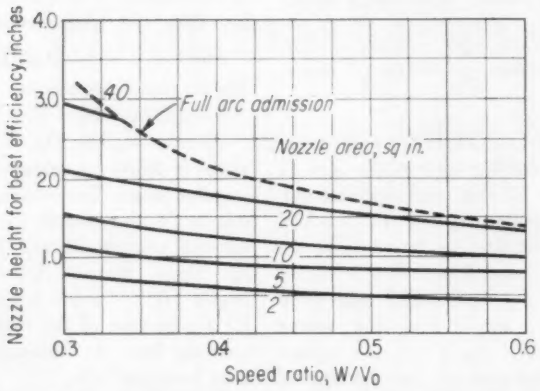
Nozzle angles. The 11-deg nozzle angle is fairly representative for an impulse stage. The smaller we make this angle, the greater the tangential velocity component and the greater the stage output. Actually nozzle angles are not made much less than 10 deg because of the area needed to pass the flow. At zero-deg angle the area becomes zero.

Nozzle angles for mechanical-drive axial-flow turbines vary from 10 to 20 deg and usually range from 11 to 15 deg. Bucket angles with these nozzles vary from 20 to 32 deg and usually range from 22 to 27 deg. Depending on bucket overlap, the ratio *bucket exit area/nozzle exit area* (called area ratio) ranges from about 1.7 to 2.0.

Considerable deviation from best efficiencies may be tolerated until an industry demands better economy. It



5 Consecutive stages of a turbine increase in height to accommodate the growing specific volume of the steam as it expands



6 Nozzle height for best efficiency with single-row-wheel at 25-in.-pitch diameter decreases with growing speed ratio

then becomes commercially feasible to make a wider range of nozzle and bucket designs available.

Turbine torque. Mechanical-drive turbines have starting torques as much as two to three times the rated-speed torque. In the above example the turbine developed 300 shp at 6000 rpm. Its torque is:

$$T = \frac{HP \times 33{,}000}{2\pi \times \text{rpm}}$$

$$= \frac{300 \times 33{,}000}{6.28 \times 6000} = 263 \text{ lb-ft}$$

The starting torque at zero speed can be figured from the velocity diagram, Fig. 1. Assuming a stalled condition with the full force of the steam spouting from the nozzles and remembering that $W = 0$, first find $V_o = 223.7\sqrt{E} = 223.7\sqrt{44.8} = 1497$ ft per sec. For stalled condition $V_x = c_2 c_1 V_o \cos\beta_2$ and total velocity producing torque will be $V_y + V_x$. Substituting in equation (A) and the preceding one we find the sum to be 2558 ft per sec.

Assuming a 25-in.-pitch diameter stage, the radius PR to the radial center of the buckets is $25/2 = 12.5$ in. the torque at zero speed is:

$T = (F/3600)(PR/12)[(V_y + V_x)/32.2]$
$= (25{,}000/3600)(12.5/12.0)(2558/32.2) = 573$ lb-ft.

The ratio *zero-speed torque/running-speed torque* $= 573/263 = 2.18$

The breakaway torque of this machine is 2.18 times the rated-speed torque.

In similar fashion the efficiency and torque can be figured for 2- and 3-row wheels, single-stage turbines, as well as for combinations of these type stages and others to make multistage turbines. Usually multistage machines have the proper number of stages and run at a speed close to peak efficiency to give breakaway torques of 2.0 to 2.5 times rated-speed torque; single-stage turbines are another matter.

Estimating torque. Modern single-stage turbines usually have two-row wheels. They range in pitch diameter from about 1 to 2½ ft; speeds range from about 1000 to 6000 rpm. Their available energies range from 50 to over 350 Btu per lb. Fig. 2 aids calculating the breakaway torque for single-stage 2-row wheel impulse turbines.

Example: Find the breakaway torque for a 300-hp 25-in.-pitch-diameter 2-row wheel turbine turning at 3600 rpm. The turbine has an actual steam rate of 32.5 lb per hphr. It takes saturated steam at 300 psig and exhausts it at 10 psig.

From the theoretical steam-rate tables we find this turbine has a $TSR = 13.5$ lb per hphr. From Fig. 2 we find the factor $K_T = 0.068$. Then $T = SHP + SR \times K_T = 300 \times 32.5 \times 0.068 = 663$ lb-ft at zero rpm. If this breakaway torque can't overcome the load static friction, a larger tur-

(Continued on page 190)

Transformer manufacturers, on the lookout for improved performance, are directing more attention to . . .

SELF-RESETTING DEVICE has optional combination alarm and signal arm which are manually reset from ground using a hot stick

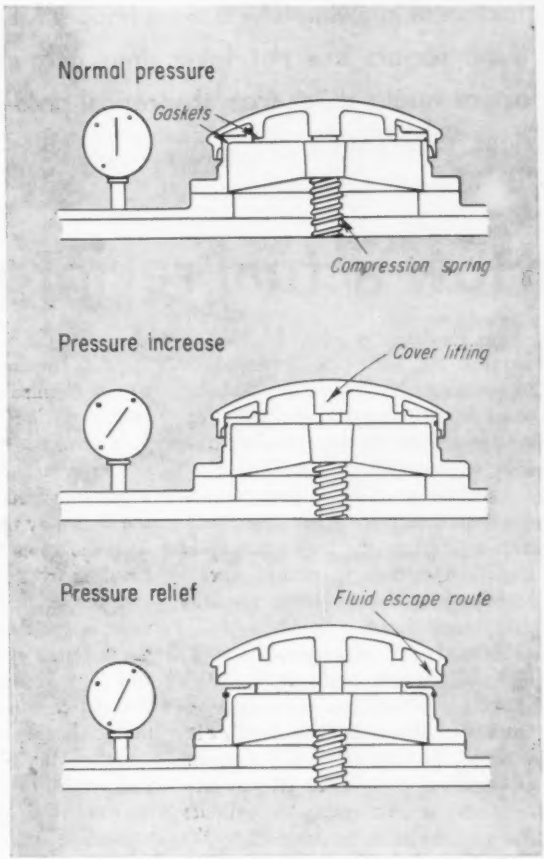
Transformer pressure relief valves

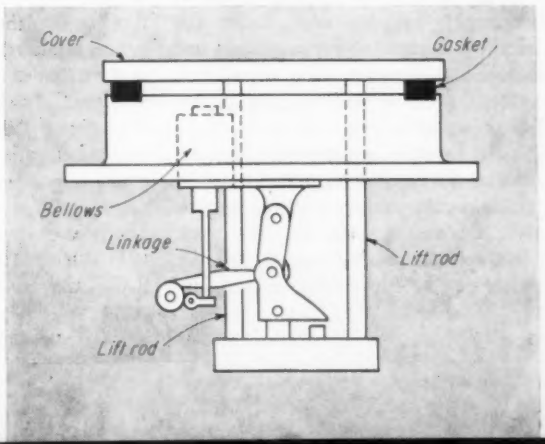
Devices to relieve the pressure that builds up in a transformer tank when a fault or extreme overload occurs, and thus avoid the danger of a tank rupturing, are usually in the form of a diaphram of predetermined bursting pressure. These diaphrams have proved adequate under most circumstances, and some manufacturers are sticking by these simple devices. Others believe, however, that there are advantages to be gained by mechanical pressure relief valves that are either self-resetting or can be quickly reset manually.

Self-resetting pressure relief valve, made by the Pennsylvania Transformer Division, McGraw-Edison Co, is designed to completely reseal when a pressure of one-half the operating pressure is reached. This feature prevents air and water from entering the transformer and doing further damage. (Manufacturer is conducting tests to determine performance of the valve while submerged under a head of liquid.) Self-resetting is also advantageous following false operation of the valve, as may occur from a rapid pressure rise caused by improper filling of gas or liquid tanks during installation or maintenance. At such times it's not necessary to de-energize transformer.

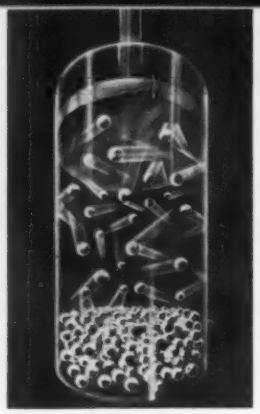
How valve works can be seen from sketch at right. When pressure in the tank exceeds predetermined spring force acting on the cover, the pressure lifts the cover and the gases escape past the outer sealing gasket. When pressure drops, cover resets. Operating pressure of the valve is set between 1½ and 3 psi above the maximum operating pressure of the system.

Quick-reset type sketched at bottom of page has cover designed to keep the device weathertight until it is manually reset. Valve is made by General Electric Co. Here's how it works: When the pressure under abnormal conditions reaches a predetermined value, a bellows (vented to the atmosphere through a breather) moves a plunger which releases a pivoted latch and trips a toggle mechanism. The lift rods are then free to rise and permit cover to be lifted up by the gas pressure. After pressure has been relieved, cover falls back against gaskets.





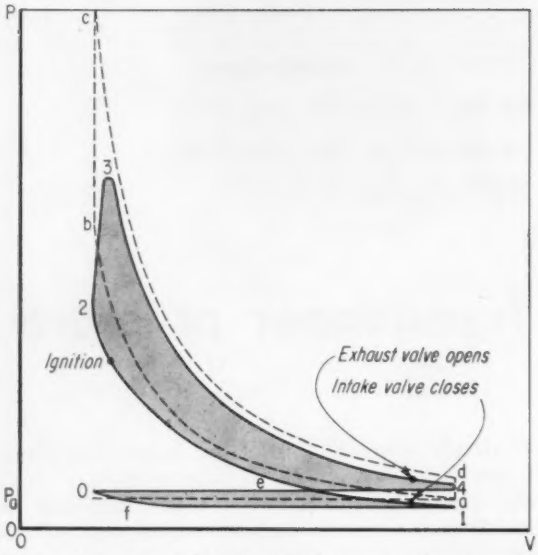
OPERATION of two types of mechanical pressure relief valves is simple. Three upper sketches show action of self-resetting type



THERMO REFRESHER NO. 22

By B G A SKROTZKI, Associate Editor

Theoretical studies always give us the satisfaction of knowing why a thing happens. But if all factors are not taken into account, actual results differ from theoretical predictions, so let's see . . .



1 Actual gasoline-fired engine P-V changes lie below theoretical with less work output reduced by negative intake-exhaust loop

How actual reciprocating engines work

Before we leave the topic of reciprocating internal-combustion engines let us compare their actual operation against the theoretical we have been dealing with. This will bring out the limitations of elementary thermodynamic analysis. While thermodynamics outlines the broad theory of engine operation it cannot always anticipate *all* the problems raised by actual conditions.

Actual P-V changes. Parts 17 and 18, March and April, 1958, POWER, outlined the theoretical operation of otto engines in detail. Fig. 1 shows the theoretical P-V diagram (dashed) of a 4-stroke otto or gasoline engine. Air enters the cylinder and gas leaves at pressure P_a so the works of induction and exhaust, measured by the area under the dashed horizontal process line, are equal and opposite. They cancel each other as far as contributing to net work output.

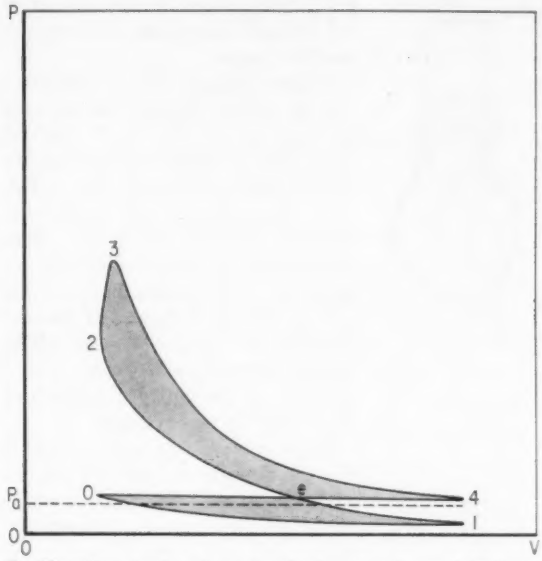
The piston compresses the air charge during process *a-b;* heat addition raises the pressure during process *b-c;* the gas expands and does work on the piston during process *c-d*; the spent gas throttles to atmosphere during *d-a*. The area *a-b-c-d* measures the net mechanical work output of the piston during a complete cycle of four strokes.

The actual changes in pressure of a gasoline-fired 4-stroke cycle engine are shown by the solid lines in Fig. 1. At *0* the gases have just finished exhausting from the cylinder at a pressure higher than atmosphere, P_a. To make a gas flow from one region to another past the restriction of valves and pipe or ducting, its pressure at the source must be higher than in the discharge region.

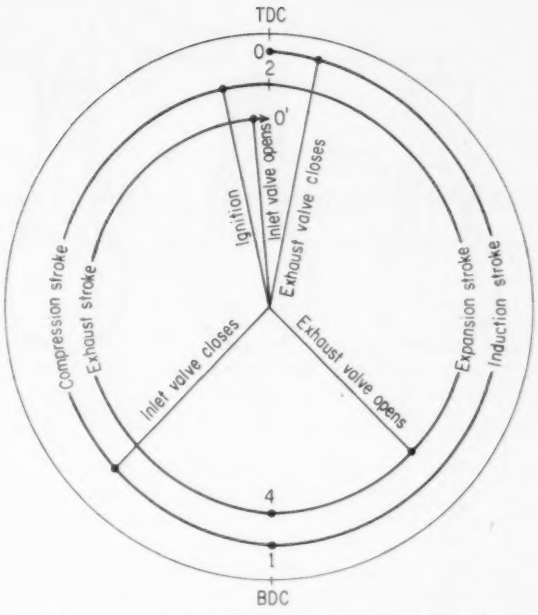
Before the piston starts its induction stroke, the inlet valve opens and the gas in the clearance volume begins expanding from *0* to *f*. After the gas pressure drops below P_a air starts flowing into the cylinder. During the entire intake stroke the air pressure in the cylinder stays below P_a.

After the piston starts its compression stroke, the intake valve closes—more about this later. The actual compression process is lower than the theoretical for several reasons: (1) The pressure at *1* is lower than at *a*. (2) During the early part of the stroke the cooler gas absorbs heat from the hotter cylinder walls, but during the later part of the stroke the hotter gas gives up heat to the relatively cooler walls. (3) Actual specific heat varies during stroke and process is far from adiabatic. (4) Air escapes from cylinder by leaking past the piston rings and closed valves. (5) Pure air contains the residual combustion gases left in the clearance volume, and vaporized gasoline.

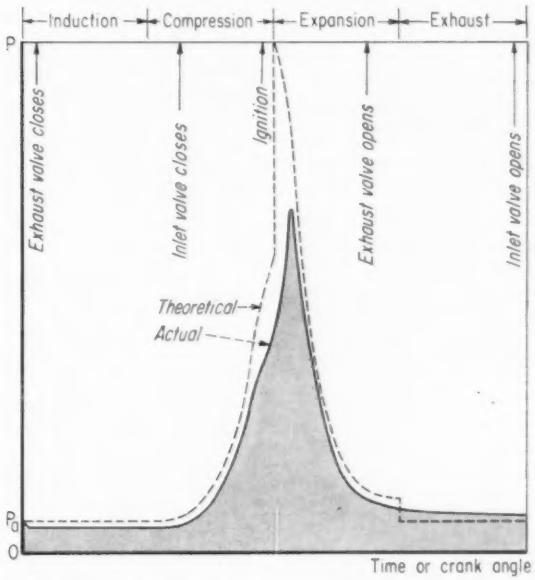
The actual cycle starts its heat addition before the end of compression because the combustion process needs time to run to completion. From the ignition point to state *3* the fuel-air mixture burns and produces heat energy. This happens during the late part of compression and the early part of expansion. The maximum cycle pressure at *3* is much lower than *c*. Several conditions cause this: (1) The high combustion temperature transfers considerable heat to the walls and cooling water. (2) The expanding volume reduces the pressure. (3) The moving piston removes energy as work. (4) Incomplete combustion does not develop full heat release. (5) Gas mixture reabsorbs some of the heat by dissociation.



2 Throttling intake of gasoline-fired engine lowers initial compression pressure at *1* to increase negative loop, reduce work



3 Valve-timing diagram compares crankshaft position for theoretical and actual opening and closing of valves and ignition



4 Pressure-time diagram of theoretical (dashed) and actual gasoline-fired engine can be converted to P-V graph for analysis

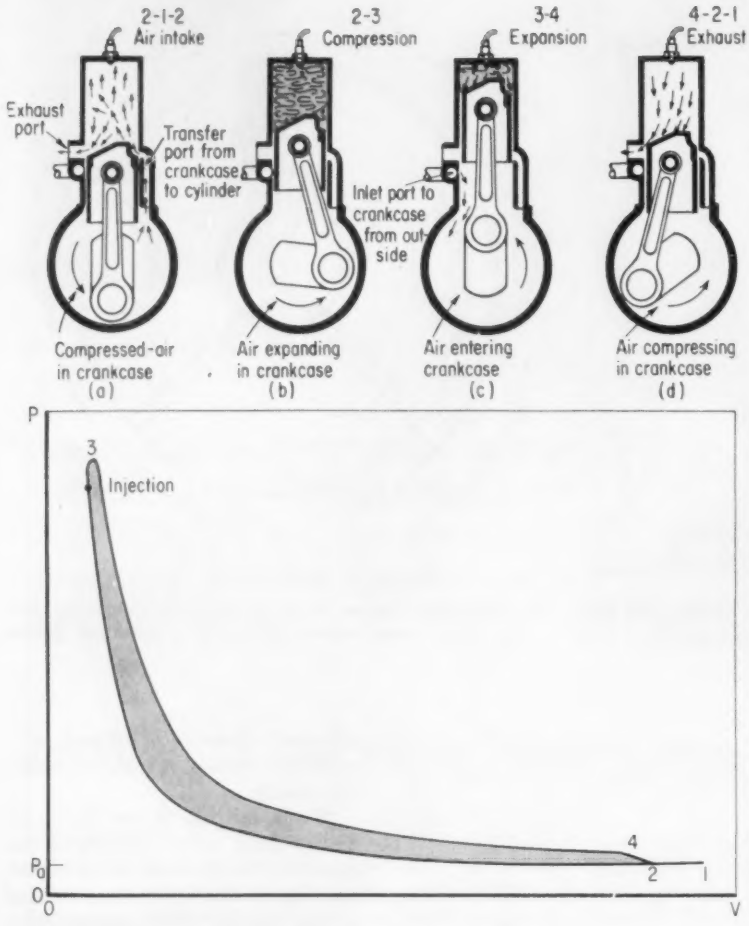
The actual expansion stroke *3-4* lies below the theoretical stroke *c-d* because: (1) Maximum pressure at *3* is lower. (2) Expansion is not adiabatic since the gas transmits heat to the cooling water. (3) Some gas leaks past piston rings and closed valves.

The exhaust valve opens before the end of the expansion stroke and allows some of the gas to leave the cylinder early. During the exhaust stroke *4-0* the piston pushes most of the gas out of the cylinder to atmosphere. During this stroke the gas pressure in the cylinder stays higher than atmosphere to overcome the frictional resistance of exhaust valve opening, exhaust manifold, muffler and piping.

Work output. As we know, the dashed loop *a-b-c-d* measures the theoretical work output of an engine. But Fig. 1 shows two loops marked in gray for the actual engine—what do these mean? In the upper loop *4-e-2-3*, during the expansion process *2-3-4*, the gas works on the piston, so total area underneath to $P = 0$ measures the gross work output.

But during the first part of the exhaust stroke *4-e* the piston does work on the gas and during the last part of the compression stroke *e-2* the piston does work on the air-fuel mixture. Again the areas underneath these curves measure work done by the piston. Difference of the coincident areas gives us the net loop *4-e-2-3* which measures the net work *output* of the piston.

Now let's examine the events around the lower loop *1-e-0-f*. From *1* to *e* the piston works on the air-fuel mixture, from *e* to *0*, the piston works on the exhaust gas. The area underneath measures gross work done *by* the piston. During *0-f-1* expanding clearance gas and incoming air work *on* the piston; the area underneath measures the work. The difference between the two work areas gives us



5 Two-stroke cycle diesel engine develops 50 to 80% more work per cylinder than a 4-stroke engine. This engine uses crankcase to precompress intake air a few pounds before it enters the cylinder. (a) Spent exhaust gas leaves through port, incoming pressurized air sweeps out residual gas. (b) Rising piston closes inlet and exhaust ports and compresses air charge, it also raises vacuum in crankcase. (c) Injected fuel ignites before expansion stroke, uncovered crankcase inlet port admits air. (d) Expanding gas works on piston, starts exhausting as soon as exhaust port is uncovered by piston; descending piston compresses air trapped in the crankcase

the net lower loop which measures the net work done *by* the piston. To get the net work output of the engine we must subtract the area of the lower loop from the upper. The difference is considerably less than the theoretical work.

Lower outputs. Fig. 1 shows the P-V changes for an engine running at full load. To vary the output of a gasoline-fueled engine we vary the mass of air-fuel mix placed in the cylinder during the induction or intake stroke. A butterfly valve ahead of the carburetor (which injects a fuel spray into the incoming air) varies the resistance to air flow entering the cylinder.

By closing down on the butterfly-valve opening we increase the air pressure drop across it and lower the pressure of the fuel-air mix in the cylinder. This, of course, lowers the mass of working fluid in the cylinder and so lowers the work output for the cycle. Fig. 2 shows the lower pressure at *1* compared to Fig. 1. This decrease reflects throughout the entire cycle by lowering cylinder pressures at *2*, *3* and *4*. The upper loop *e-2-3-4* is smaller in Fig. 2 than in Fig. 1, while the lower loop *e-0-1* is larger. So we have a "double" effect that lowers the net output of the engine, which is the difference of the two loops.

Valve timing. Fig. 1 indicated that the valves and ignition operated at times different than the theoretical. These can be easily studied with the aid of a timing diagram, Fig. 3. This shows the postion of the crank throw when the different events take place. TDC means *top dead center* and corresponds to the piston in its full-in postion, that is, at the end of its compression or exhaust strokes. BDC means *bottom dead center* corresponding to the full out position of the piston in the cylinder.

Fig. 3 corresponds to Fig. 1 and 2. For the theoretical cycle the exhaust valve closes and inlet valve opens at *0;* the inlet valve closes at *1;* ignition takes place at *2;* the exhaust valve opens at *4* and closes at *0'*. As we see, the actual events take place at appreciably different times.

For the actual cycle the inlet valve opens before the beginning of the cycle and the exhaust valve remains open till about 10 deg after the beginning of the cycle. Early inlet opening gives extra time for accelerating the air which is important in our modern high-speed engines. Late outlet closing gives extra time for getting out more of the exhaust gas which lowers the dilution of the fresh air-fuel mixture.

The inlet valve doesn't close until about 45 deg after *BDC*. The air coming in at considerable speed can pack more of itself into the cylinder even when the piston has already moved through one-quarter of its compression stroke. The pressure wave set up inside the cylinder by the piston doesn't get to the inlet valve until about that time.

Ignition takes place at various angles before TDC depending on the load and speed. The exhaust valve opens as much as 45 deg before BDC. This blows down some of the pressurized gas before the end of the expansion stroke and causes a small loss in work output. The advantage lies in getting the gases moving earlier and lowering the pressure during the exhaust stroke.

Pressure-time diagram. Fig. 1 and 2 are indicator diagrams that can be taken directly off the engine if its

(Continued on page 182)

Kill "boiler hp"?

That's what POWER's August editorial urged. The experts are divided. Here's what they say, pro and con, with some alternate suggestions

(For editorial comment, turn back to p 73)

FOR

. . . in complete accord . . . We have endeavored over the years to preach the same gospel which you present by this editorial.

One point that is extremely important and which you do not cover . . . is the fact that all of the watertube packaged boilers sold on a national basis, and also all of the firetube boilers, have in effect a "black" furnace, and the absorption rate per sq ft of this surface is way in excess of the 10 sq ft provided by the expression . . . "boiler hp."

FRANK F HOHNHOLT
Superior Combustion Industries, Inc

. . . congratulations . . . for the fine article on comparison of "boiler horsepower" and "lb per hr." We are of the firm belief that "lb per hr" is definitely the standard unit for measuring boiler capacity. We feel that "boiler horsepower" is not the true standard and definitely should not be written into specifications.

H R FREEDEN
Ames Iron Works, Inc

. . . Bhp and edr too . . . You might just as well make it a dual killing by burying the expression "edr." When a mechanical engineer figures heat loss in a building in design stage, he figures it by the Btu method.

The old cast-iron radiator, condensing ¼ lb per hr (240 Btu) for each sq ft of . . . surface . . . is a thing of the past. Hot water has replaced steam as the heat-transfer medium for most space-heating systems. Finned-pipe baseboard convectors have replaced the old cast-iron radiators.

It is just as senseless to use "edr" as it is to use "boiler hp." Let's bury both. Amen.

A C PATTERSON
The A C Company

. . . crusade commendable . . . The term "boiler hp" has in our opinion outlived its usefulness and is now a detriment to the industry. It leads to confusion, for "boiler hp" without percent rating really is meaningless. To the manufacturer, the amount of steam which can be delivered from a given surface area is a function of many variables. There is no magical relationship between boiler hp or percentage rating and the amount of heat which a given surface can *(Continued on page 172)*

AGAINST

. . . retains usefulness . . . The engineering department of our company is inclined to favor the continuation of "boiler hp" to define the capacity output of a boiler. Our preference is based on the fact that through years of experience, we have found that when ratings are asked for in "lb of steam delivered" the request fails to state in full the conditions under which these "lb of steam" are wanted . . . . Many inquiries fail to state whether saturated or superheated steam is involved . . . .

We feel sure you will concur that if "lb of steam" instead of "boiler hp" is used to define the capacity of a boiler, the feedwater temperature, the dryness of the steam, the steam pressure, and sometimes degrees of superheat wanted should all be clearly given in a request for a boiler of desired capacity.

To repeat, we find that very few inquiries . . . where the boiler capacity is expressed in "lb of steam", give the full information required and for this reason we think that . . . "boiler hp" . . . still retains its usefulness.

G W BOHN
Preferred Utilities Manufacturing Corp

. . . ain't mad at nobody . . . The first thing I want to say . . . is that I ain't mad at nobody although it may seem that I feel pretty strongly about the subject.

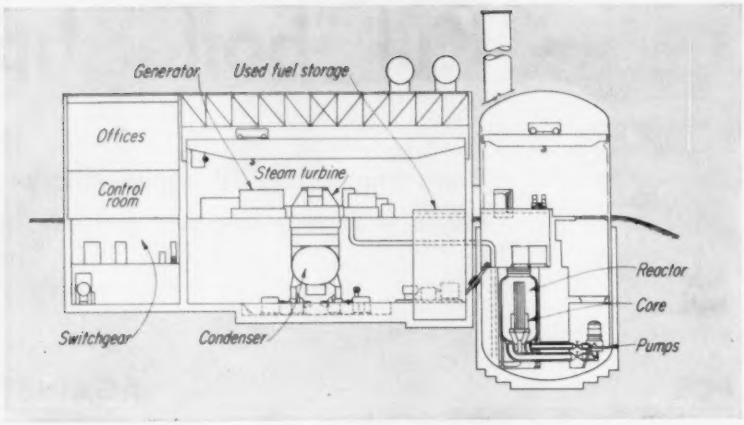
If, like Omar Khayyam, we could start all over again, or rather, if we were just starting, I wouldn't find it hard to agree that perhaps we should rate boilers in "lb per hr" rather than in "hp".

But here we are in the 20th Century. We sell boilers to corner tailor shops and to bakers and to farmers and butchers and candlestick makers. To expect a program of re-education to convince people like this that they should ask us to quote on a boiler for 30 lb per hr or 60 lb per hr or 100 lb per hr would be just asking too much.

I recall once when I was talking to a dry cleaner who wanted a boiler, I asked him what size he wanted and he said "100-lb" boiler. I said, "All of our boilers are built for 100-lb pressure—what *size* of boiler do you want?" His reply was, "I want a 100-lb boiler". The only way I could get through to this man was to say that we have some boilers that are 1-ft high and some 2-ft high and some 3-ft high and some 4-ft high, etc, and they are all good for 100-lb pressure.

Other dry cleaners know *(Continued on page 176)*

Since work began on the CRBR project in May 1957, rapid progress has been made in the initial design of the reactor. Studies by the builder now show that . . .



1 Controlled recirculation boiling reactor with its recirculating pumps and built-in nuclear superheater stands in containment tank, *right*. Turbine is rated at 66 mw

Nuclear superheating can be used

The Controlled Recirculation Boiling Water Reactor (CRBR) will be built by the Allis-Chalmers Mfg Co for the Northern States Power Co. A group of 11 midwest utilities formed the Central Utilities Atomic Power Associates (CUAPA) to contribute $3,650,000 toward research and development. The Atomic Energy Commission contracted to contribute funds toward both research and development and waive an additional $1 million fuel-use charge. Total installation for the Pathfinder Atomic Power Plant is estimated at $28.8 million. Pioneer Service and Engineering Co will serve as architect-engineer.

Objective. The plant to be built near Sioux Falls, S. D. will have a gross 66-mwe capacity. With starting scheduled for June 1962, the designers and owners intend to build a "kilowatt factory" without frills and unnecessary facilities.

Selection of a boiling water type reactor was greatly influenced by the wealth of experience with steam systems in conventional plants. Significant too are the excellent results obtained from Argonne Lab's direct cycle EBWR which has operated for almost two years. For experimental purposes, fission products were allowed to leak from fuel into the reactor before opening the turbine. Activity inside the turbine after shutdown was only two milliroentgens per hr. (Current standards allow 5000 mr per yr.)

Three large-capacity circulating pumps help to reduce the capital cost of the CRBR, Fig. 1 and 2. They allow a very high heat output from the core while maintaining good flux distribution. Without the pumps, power density in the core top drops to a fraction of the average because of the large void fraction in the water moderator.

Because water circulating rate does not depend on density differences, as in natural circulating systems, the pumps permit high feedwater temperature. This gives efficiencies that approach those of modern conventional power plants.

Variable-speed control on these pumps gives reactor control in addition to the shim rods, and will eliminate any need for continuous bypass steam to the main condenser. The pumps need very little power because of the low head requirements.

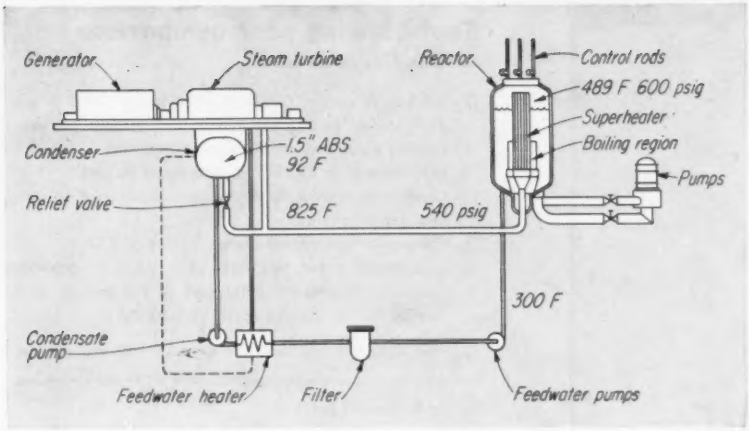
Valves in the suction and discharge pipes permit servicing one pump at a time during reactor operation. After isolating a pump, radioactivity in the reactor water decays quickly to a tolerable level. Each pump is in a shielded compartment.

Superheater. High temperature raises plant efficiency and avoids moisture problems of saturated steam. Fig. 1 2 and 3 show operation of the nuclear superheater. The reactor has two close-coupled regions. The annular boiling region produces saturated steam bubbles in the water which rise to the dome of the reactor vessel. The steam then enters parallel tube assemblies containing concentric steel-clad tubular fuel elements which comprise the central core region, Fig. 3.

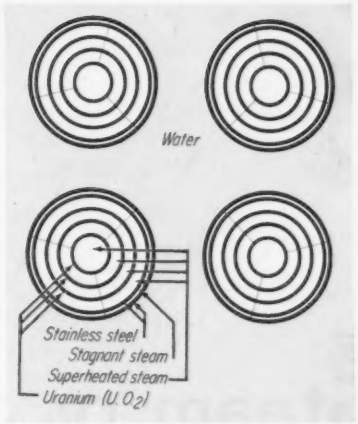
In flowing downward, the steam heats to 825 F and passes through the reactor bottom on its way to the turbine. The water between the superheater tubes moderates the neutrons. Stagnant steam between the outer two stainless-steel tubes acts as thermal insulation.

Both regions of the core have control rods. Because of the close coupling between regions, the superheater rods will only need occasional adjustment independent of power demand.

The superheater is designed so reactivity does not change appreciably when flooding the superheater tubes with water. This permits submersion during refueling, simplifies refueling operations and eliminates hazard of sudden reactivity changes resulting from accidental flooding of superheater while running. Adding the superheater pays a dividend by producing more uniform heat release and burnout throughout the core.



2 Regenerative cycle of CRBR plant supplies 300-F feedwater to reactor for an overall thermal efficiency of 30.5%. Superheater drops steam pressure by about 60 psi



3 Nuclear superheater uses concentric UO_2 tubes inside of two steel tubes

for boiling reactor

By C B GRAHAM, Chief Engineer,
Nuclear Power Division, Allis-Chalmers Mfg Co

Nuclear superheater fuel costs, using 20% enrichment, appear to be little higher than for conventional fuels. The steam absorbs all the nuclear heat but not all that released in a fossil-fuel-fired superheater. Superheating amounts to less than 20% of the total heat in the steam. We expect future development of low-enrichment fuel elements for superheating to reduce nuclear fuel costs to competitive values.

Steam separator. Steam bubbles must be removed from the water before it recirculates. They will cause pump cavitation, less efficient reactor operation, possible reactor instability.

Small surface for steam release and the high water velocity in the downcomer outside the core make it necessary to use steam separators to remove steam bubbles. The separators work on the cyclone principle. Centrifugal force acting on the rotating liquid moves the steam to the center of the separator. Several separators around the inside of the reactor vessel, above and outside the core, receive the bubble-laden water and discharge the steam to the dome and the water to the reactor bottom.

Plant layout. The turbine-generator and its conventional auxiliaries stand in a conventional building. Light shielding covers air ejectors and steam mains. *(Continued on p 192)*

I—CRBR with nuclear superheater (preliminary)

PLANT

Power, boiling region	164,000 kwt
Power, superheating region	39,000 kwt
Total core power	203,000 kwt
Gross electrical capability	66,000 kwe
Net electrical output	62,000 kwe
Net efficiency	30.5%
Steam outlet pressure	540 psig
Reactor operating pressure	600 psig
Temperature, boiling region	489 F
Outlet temperature, superheating region	825 F
Gross heat rate	10,370 Btu/kwhr
Containment shell size	50 x 115 in.

REACTOR

Vessel size	11x26 ft
Vessel wall thickness	3 in.
Total core dimensions	6x6 ft
Dimensions of superheating region	6 ftx30 in.
Fuel, boiling region (Al clad)	1.6% enriched UO_2
Fuel, superheating region (SS clad)	20% enriched UO_2
Fuel, loading boiling region	100 kg (U-235)
Fuel loading, superheating region	24 kg (U-235)
Power density, boiling core coolant	96 kw/liter
Average heat flux, boiling region	115,000 Btu/hr/ft^2
Average heat flux, superheating region	52,000 Btu/hr/ft^2
Maximum heat flux, boiling region	290,000 Btu/hr/ft^2
Maximum heat flux, superheating region	150,000 Btu/hr/ft^2
Recirculation rate	60,000 gpm
Recirculation pump power	620 kw

Steam or air:

Which costs more for boiler cleaning?

By L B SCHUELER, Consultant
The Cooper-Bessemer Corp

Soot-blowing cost comparison

Table I—Air system costs

(1) Air energy cost = 0.51* × air required (1000 lb per day) × fuel cost ($ per million Btu) × days per year
(2) Cooling water cost = .05 × air energy cost
(3) Maintenance = $3.80** × compressor hp (net)
(4) Compressor system fixed charge = cost × 0.13 (annual capital charge)
(5) Compressor space fixed charge = cost × 0.13
(6) Compressor power fixed charge = 0.22 × capacity (cfm) × incremental plant cost ($ per kw) × 0.13
Annual cost air blowing = (1) through (6)

*Assumes 7000 Btu fuel *input* per bhp and 0.30 bhp per cfm free air
**Applies to reciprocating compressors. Use $1.50 for centrifugal

Table II—Steam costs

(1) Steam energy cost = 1.40* × steam required (1000 lb per day) × fuel cost ($ per million Btu) × days per year
(2) Water pumping and treating cost = steam rate × unit cost × days per year
(3) Blower maintenance cost = excess blower maintenance cost ($ per year)** × number of blowers
(4) Treating plant and evaporator maintenance = pro-rata cost of entire system
(5) Boiler capacity fixed charge = blower steam rate (lb per hr max.) × incremental cost of boiler ($ per lb steam) × 0.13 (annual capital charge).
(6) Treating plant and evaporator fixed charge = pro-rata charge entire system × 0.13
(7) Treating plant and evaporator space charge = pro-rata charge entire system × 0.13
Annual cost steam blowing = (1) through (7)

*Assumes 1400 Btu fuel *input* per lb steam
**Estimate $30.00 per year per blower unit

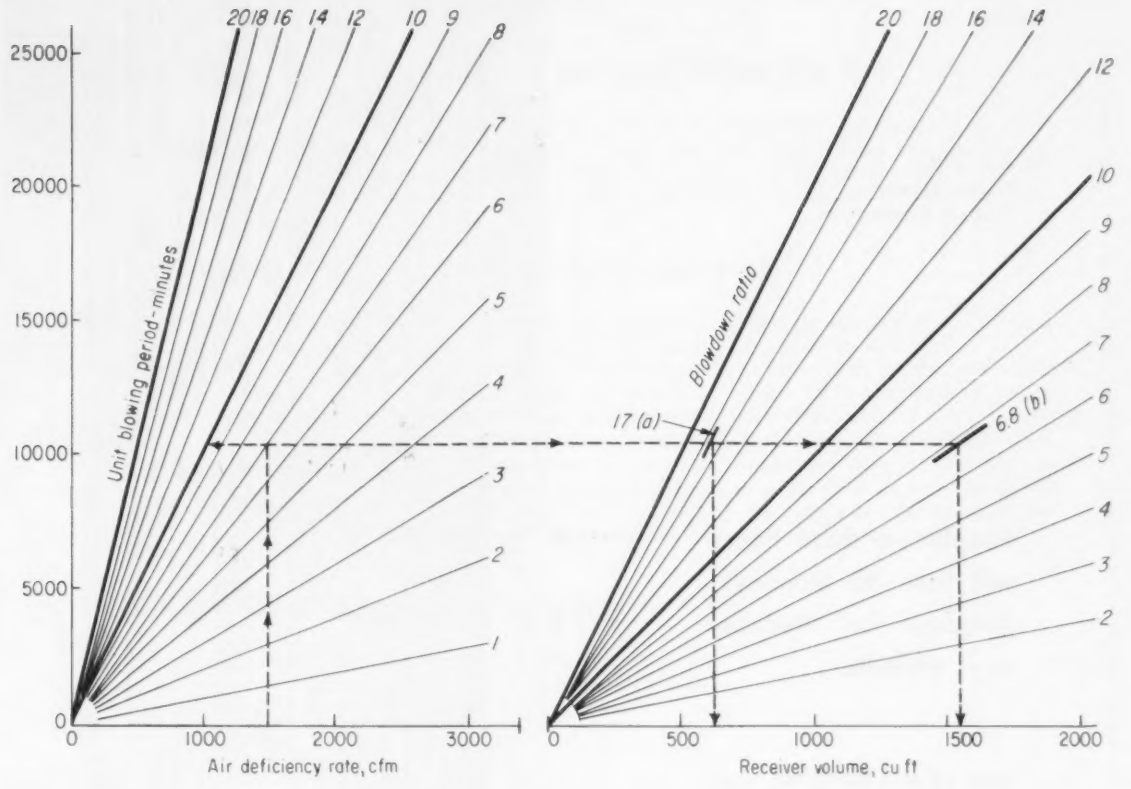
In-service removal of boiler slag and flyash has come a long way since mechanical soot blowers replaced the hand lance. Though mechanical cleaning has unquestionably upped boiler operating availability, efficiency and safety, it has followed empirical practice since its inception.

Mechanically-driven lances commonly used steam from the boiler being cleaned, generally because of its apparently lower initial equipment cost and its ready availability in unlimited quantity. As cleaning practices developed and larger boilers came along, blowing with compressed air appeared to offer some desirable features: (1) It eliminated poor cleaning when steam pressure wasn't high enough. (2) Resulted in better cleaning due to inherently better blower operation programming. (3) Avoided pure condensate losses due to steam blowing and drainage. (4) Stopped severe quenching action of wet steam (or water) on hot pressure parts. (5) Avoided high blower equipment and system maintenance (erosion, corrosion, packing wear, etc.) (6) Avoided waste often associated with unlimited availability of steam. (7) Meant better housekeeping due to absence of steam and condensate leakage. (8) Resulted in generally better economy on an evaluated basis.

Experience has proved that these advantages usually are realized with air blowing and it's possible to make a realistic evaluation if the pertinent factors are applied. If we consider an electric power-generating station as an energy source—with steam from the boiler for steam blowing and electricity from the generator to drive the compressor for air blowing—we have the major factors for making such an evaluation. But there are other pertinent factors which perhaps have not been too well understood or accounted for in the past. Let's take a look at them.

Air blowing costs are summarized in Table I which includes recommendations on the specific factors involved in the computations. These have been set up as an *annual cost* computation with fixed charges capitalized to an annual basis. Blower maintenance has been omitted since it will be evaluated "by difference" with the comparable steam figures. The compressor maintenance figure may seem high to some, but this amount considers long range operation and parts replacement rather than the favorable figures that are sometimes quoted for a few initial years' experience.

Steam blowing costs are correspondingly summarized in Table II. Here we find blower maintenance cost as an annual *excess* cost over that for air blowing. The recommended figure used here is considered quite modest. Much higher figures can be substantiated, particularly if long range maintenance and replacement costs are considered.



RECEIVER SIZE is easily found from chart. Compressor rate subtracted from blower rate gives total air deficiency for all blowers. Total deficiency divided by blowdown ratio (compressor output, psi minus line pressure, psi divided by 14.7) gives the receiver volume

Neither table has figures for blower-system equipment cost. Since blowers are usually built for steam or air without significant design change they can be eliminated as a factor. And, though piping systems are different for steam than for air, a cost comparison of several installations showed no substantial difference for the two types. Consequently they've also been eliminated.

Some considerations are involved in the development of Tables I and II which can appreciably affect the final result of such evaluations. Example: Relative quantities of steam or air required to do equivalent cleaning aren't clearly defined by any basic principles. This leaves the situation open to many interpretations. It has been stated that "For a given nozzle, the *same* flow rate in lb per hr *steam or air* will produce the same energy as measured by impact pressure on a pitot tube at a fixed distance from the nozzle center, etc." In plain language this means that *equal weight rates* of steam or air will produce *equal cleaning*. Then, for steam cleaning there's an additional condensate loss due to cooling in lines and leakage through traps, which is usually estimated at about 15% of total blowing steam. On this basis, and using Tables I and II, we find that the relative energy cost for steam to air for equivalent boiler cleaning is $1.15 \times 1.40/0.51 = 3.16$ times greater for steam.

Air compressor operating pressure and receiver sizing are factors which have been getting considerable attention recently. Earlier air blowing systems generally used 500 psig compressor output. This was because the small boilers and correspondingly few blowers didn't need high compressor capacity in relation to blower flow rate. At this point, let's establish basic relationships involved in the matter of compressor and receiver design determinations, as follows:

$$\text{Net compressor capacity, cfm} = \frac{\text{Total air for cleaning, cu ft per day}}{1440}$$

To this net figure there is generally some reserve added for safety and contingency. Then, number and size of compressors is tentatively selected to arrive at an *actual compressor capacity*. Subtracting this from the blower rate gives *air deficiency rate*.

Air deficiency rate for each blower unit multiplied by its blowing time in minutes gives unit total air deficiency. Calculating this for each blower gives total air deficiency which governs compressor-receiver design requirements. Receiver size, cu ft, is equal to Total Air Deficiency/Blowdown Ratio, where:

$$\text{Blowdown Ratio} = \frac{\text{Comp discharge, psi–line press, psi}}{14.7}$$

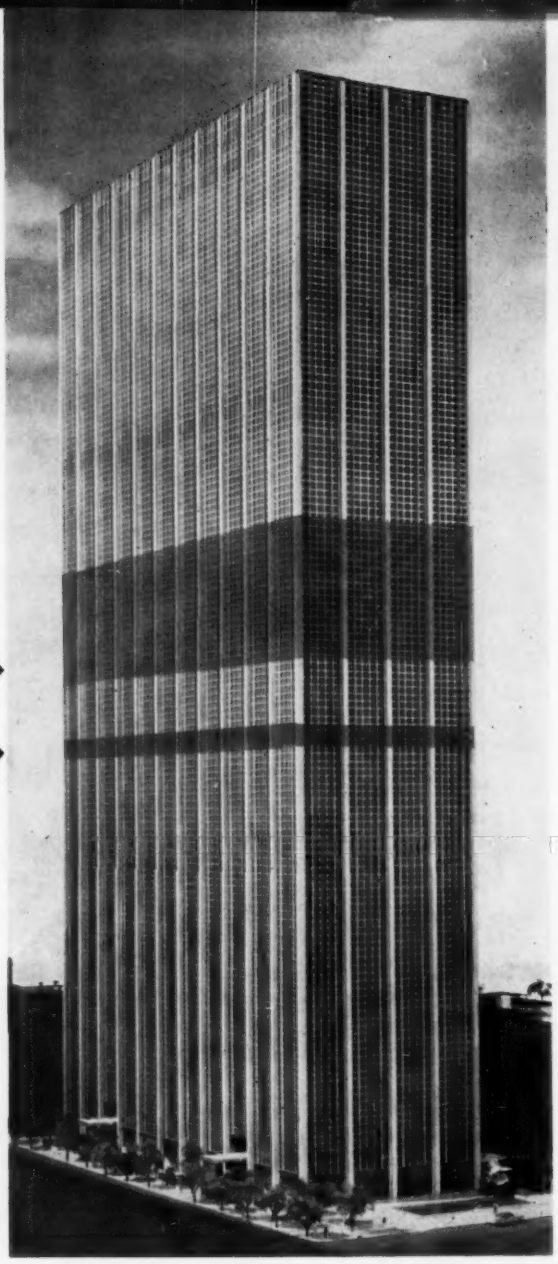
Receiver size determination, based on the variables involved, is

(Continued on page 198)

By A C ZUCK
Project Supervisor
Syska & Hennessy, Inc

People on these floors will take off Mondays, Tuesdays or Wednesdays while the . . .

Rest of the building will be idle Saturdays and Sundays. That's why design of the new Time Inc home calls for . . .



Floor-by-floor control of cooling air

Time Incorporated is scheduled to occupy a 20-floor block in the middle of their new 47-story building now going up in Mid-Manhattan. Working schedules for Time personnel in this chunk of the building will involve every day of the week, since publishing deadlines decree some staffers week-end at the beginning of the week—Monday, Tuesday or Wednesday—while the rest spend the more conventional Saturday and Sunday away from the job.

These unusual hours didn't affect structural design. But they did limit selection of an air-conditioning system. Planned for completion in the fall of 1959, building design called for 100% air conditioning. Working up a method that would do this job wasn't hard. The big problem was finding a scheme that would work efficiently in the face of mixed occupancy times.

Total heat load will come to about 6000 tons. Turbine-

Here are pros and cons on three ways of doing the job

Syska and Hennessy, Inc worked up three systems for the job before submitting their proposal. They knew that one of them—the standard approach to air delivery in tall buildings—wouldn't be good here, but brought it up so the Time people could see why.

Choice of methods was (1) low first cost coupled with high running expense (2) the reverse (3) one in between. At that point Time could take their pick.

1 Single duct system—standard air-delivery approach

This is a simple technique: one riser feeds air to several floors. Risers in east and west zones cover six levels each; two central-zone risers handle twelve floors each. Control over air is limited to presizing ducts and use of limited fan control.

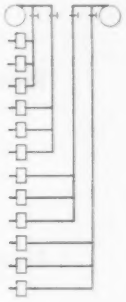
Keeping the system simple yields low first cost. But the big disadvantage—no flexibility—boosts operating cost. If only a few floors of those fed by one riser are busy, the rest get cooled air when they don't need it. Since air is precooled to handle the heat load of occupied levels, temperature plummets in idle areas getting this same cool air. People returning from weekends find their offices too cold for comfort; since comfort is the aim, this plan is out.

Reheat can be used on conditioned air to keep temperatures up during weekends. But now not only is cooling effort for idle floors lost, money also goes down the drain on wasted reheat. So, even though first costs are good, running costs will go high, and stay there.

2 Multi-riser system—cuts operating costs

To get this system, just add more risers to the single-duct method. Multi-riser plan slashes number of floors served by one duct from six or twelve to three. Dampers (sketch) can cut out one of the two risers served by any one fan.

What's the benefit?—it cuts waste. Number of empty floors fed cooled air is trimmed to two. Drawback here is high first cost, since ductwork is about doubled, and fan costs rise. More fans of smaller capacity are used to get flexibility. But even though first costs are higher, they're a one-time deal and might be chosen over constantly high operating cost.



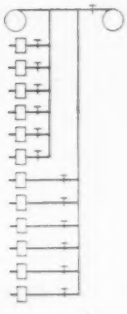
3 Flexibility system—offers complete control

Back again to single ducts, but with a major difference: complete control is added. Put dampers, pressure-sensitive microswitches at each floor take-off, and vortex dampers in fan inlets.

To cut off a floor from the system, shut the local dampers. Duct pressure goes up, yes. But switches sense the rise and adjust dampers to (1) decrease amount of air fans can deliver (2) control cfm to each level. Thus control maintains design flow-rate.

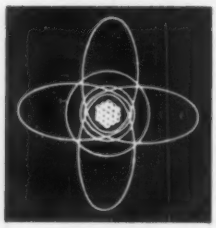
Finally, feed fan discharges into a common header. One fan then serves many floors, cutting costs when few floors are busy.

Advantages in this case are reasonable operating cost, a minimum of complaints. And first cost is lower than for a multi-riser design. Since flexibility does the job, it got the nod here.



driven centrifugal compressors were selected to do the cooling, with units totaling 3400-tons cooling capacity located in the basement and the rest up on the roof. Steam purchased from a central steam plant drives the turbines, serves the reheat units, and provides heating capacity. Two levels, the 10th and 35th, were put aside for primary-delivery and return-air fan equipment; smaller fans are located on these floors and in basement.

Once the placement of equipment was determined, the next problem was air distribution. Office floors are divided into four interior zones and the perimeter areas. Feed from each riser to the floors is limited to one zone per riser, while the number of floors serviced by each vertical duct depends on distribution system finally selected. Method selected, see above, solves the cost problems and still provides a design for effective conditioning.



Nuclear notes

By B G A SKROTZKI, Associate Editor

Must reading for the nuclear industry was issued by the Edison Electric Institute in its bulletin No. 58-13 "Status and Prospects of Nuclear Power—An Interim Survey" (As of July 1958). This is a 52-p report of its Technical Appraisal Task Force on Nuclear Power. Copies can be bought at $1.00 each by members and $2.50 each by nonmembers from the EEI at 750 Third Ave, New York 17, N.Y. Below we give report highlights.

No reactor is known that can be guaranteed to produce electrical energy anywhere in the U.S. at a cost equal to or less than that produced by conventional plants. At other spots in the world some reactors might be competitive. No one factor causes the present high cost of nuclear-produced energy; equipment, fuel, operating and maintenance costs must all be pared. No reactor ideas make firm promises that they can cut costs, but most have possibilities of considerable improvements and may eventually be economic.

Prices of enriched uranium and heavy water are not commercial prices, but established by the government. Sale price of natural uranium depends on government guarantees and government contracts for milling. Price advantages are enjoyed by the power industry because of the heavy production for weapons stockpiling. The U.S. government makes adequate amounts of separated materials available to industry at reasonable prices.

Processing costs for fuel-element fabrication carried out by private companies is hampered by the small volume of work. AEC and the British have achieved low costs for high-volume plutonium production reactors. Chemical processing has only been done on a minute scale by private industry. AEC offers to do this on the basis of costs figured for a hypothetical plant.

Buy-back prices of Pu and U-233 affect the selection of reactor types and fuel cycles. At $12 per gm of Pu, recycling Pu for fuel may be worthwhile. At $30 per gm of Pu there would be no incentive to develop Pu-burning reactors when U-235 can be bought at $17 per gm or less; reactors producing Pu and power could probably run at a net fuel cost of 1 to 2 mills per kwhre. Higher buy-back price for Pu than for U-233 would place thorium-converting reactors at a disadvantage.

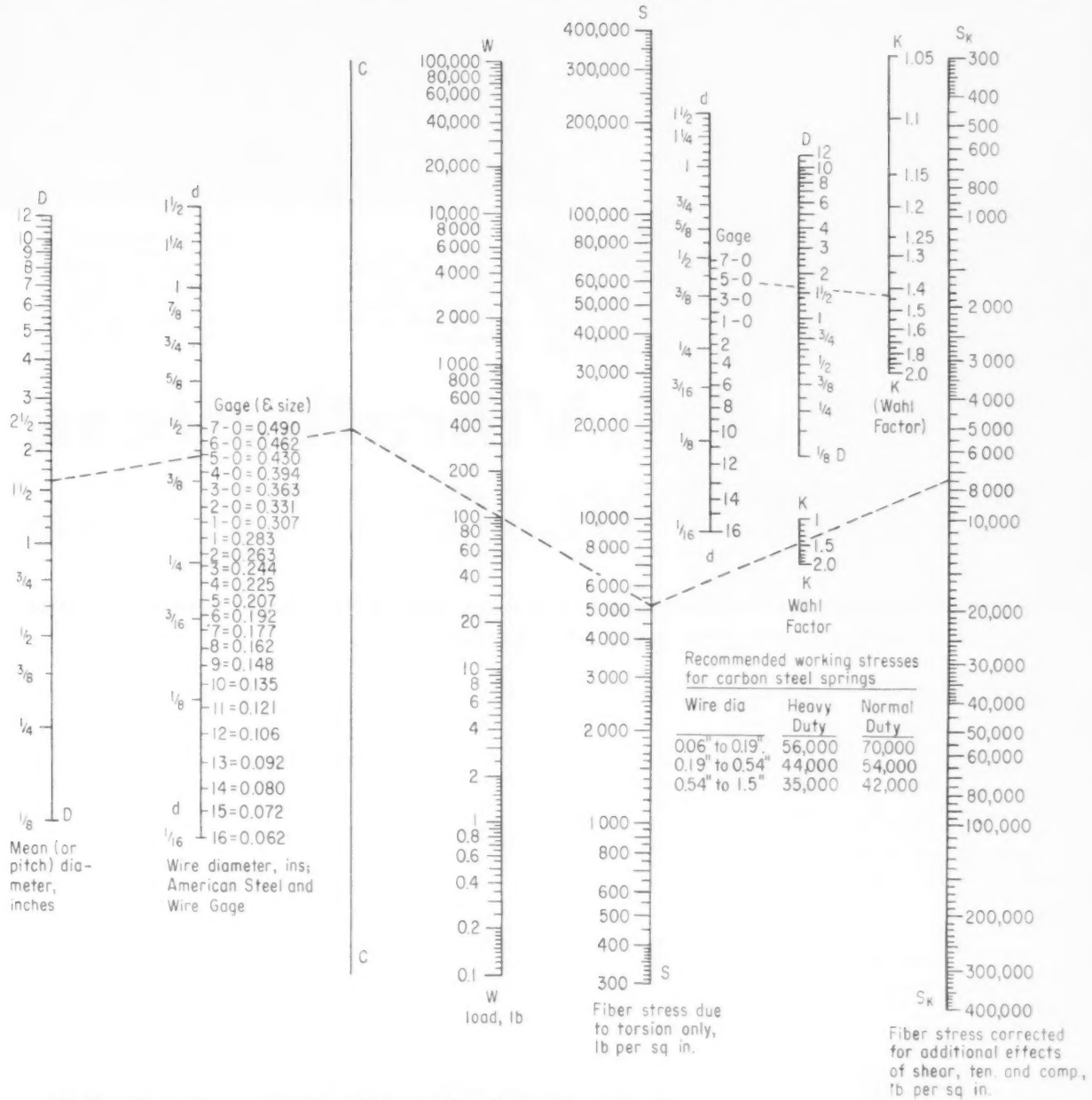
Higher steam temperatures will have important effects in improving thermal efficiencies and reducing investment costs. Developing materials and solving corrosion problems must have high priority in reactor activity.

Natural vs enriched uranium fuel still must be resolved. Their relative merits depend on the actual burnup experience which is not yet available. The effect of loss of reactivity is a vital consideration in determining burnup. Enriched uranium fuel allows using more conventional construction materials in a reactor, but the higher concentration demands higher burnup to get down to an acceptable fuel cost.

Fluid fuels offer some tantalizing advantages in eliminating fabrication costs, reducing decontamination costs, maintaining reactivity and eliminating radiation damage. But corrosion, containment and radioactive fluid raise big problems.

Power's data sheet

No. 315



Helical springs made of round wire or rod—1

This first of two *Data Sheets* figures the stress developed in a spring by an applied load. Corrected fiber stress in lb per sq in. is figured from $S_k = 8WDK/\pi d^3$ where W = applied load, lb; D = mean diameter of spring, in.; d = wire or rod diameter, in. (or gage No.); K = Wahl fiber stress correction factor figured from:

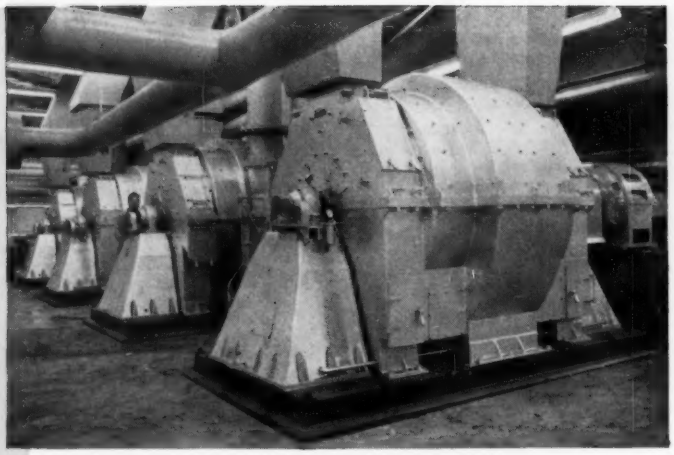
$$K = \left[(4\ \frac{D}{d} - 1)/(4\ \frac{D}{d} - 4) \right] + 0.615/(D/d)$$

Example: Spring has $D = 1\frac{5}{8}$ in.; $d = 5\text{-}0$ gage; $W = 100$ lb; find the spring stress.

First find K from small nomogram by joining $1\frac{5}{8}$ in. on D scale to 5-0 gage on d scale to find $K = 1.43$. Next on main nomogram join $1\frac{5}{8}$ in. on D scale to 5-0 on d scale to intersect C scale. Join this point to 100 on W scale and project to find 5200 lb per sq in. on S scale. Join this point to 1.43 on K scale and find maximum fiber stress of 7460 lb per sq in. on S_k scale.—J F Waters, *Westerham, Kent, Eng.*

© POWER

Latest model Riley #350 Pulverizer with Metering Coal Feeder which has a magnetic separator to remove metals escaping the conveyor magnets.



Four Riley 550 Duplex Pulverizers installed in the Picway Station of Columbus & Southern Ohio Electric Co. — one of the many Public Utilities that are using Riley Pulverizers.

The Quiet, Vibrationless RILEY PULVERIZER is

You will not only appreciate its quiet, vibrationless operation but ALL OF THESE OTHER ADVANTAGES:

Dependability

Riley "50" Series Pulverizers are rugged in construction, simple in design concept. All moving parts are on a single shaft rotating on two main bearings. They require no worm gears or other complicated mechanisms. A high degree of selectivity of rejection of foreign material prevents damage to pulverizer parts.

Sustained High Fineness

Tungsten Carbide faced pulverizing elements last for years providing a high degree of pulverized coal fineness.

No Loss of Capacity With Wet Coals

Flash drying in crusher-dryer section evaporates all free moisture. Coal can be dripping wet when entering feeders without loss of capacity. Adequate primary air temperature is provided.

Extreme Load Ranges

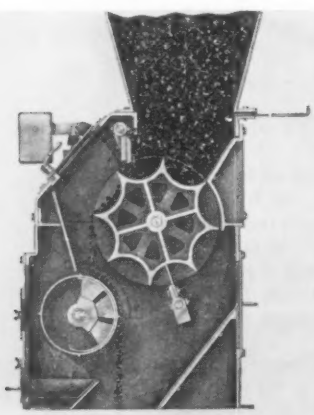
There is no lag with Riley Pulverizers to conform to load changes. Change in feeder rate gives instantaneous change in pulverized coal output.

No Adjustment Necessary to Maintain Fineness

Riley Pulverizers need no springs or other wear compensating devices which require shutdown for adjustment.

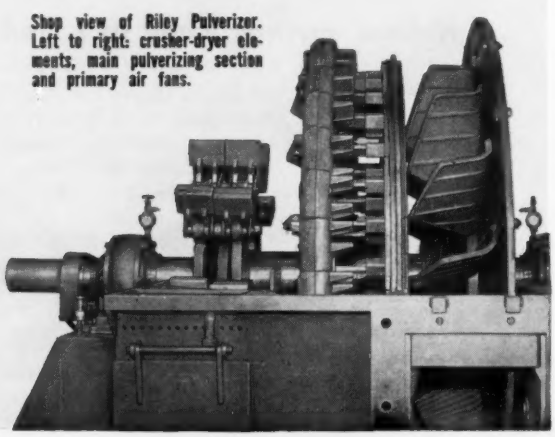
A Minimum Labor Cost in Removing Rejections

Tramp metal and other foreign materials are easily removed thru a door in the crusher-dryer section and thru one in the feeder.

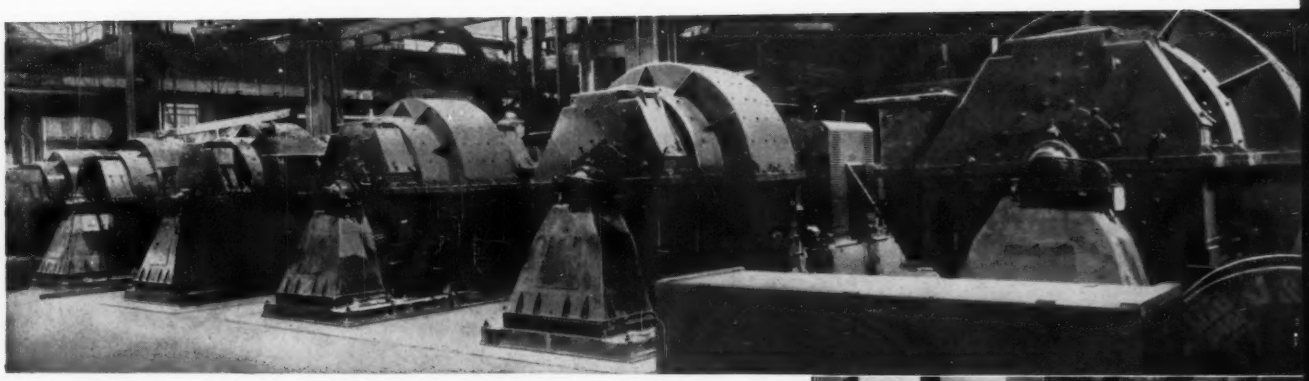


Cross section of Riley Feeder shows how coal is metered and the new magnetic separator.

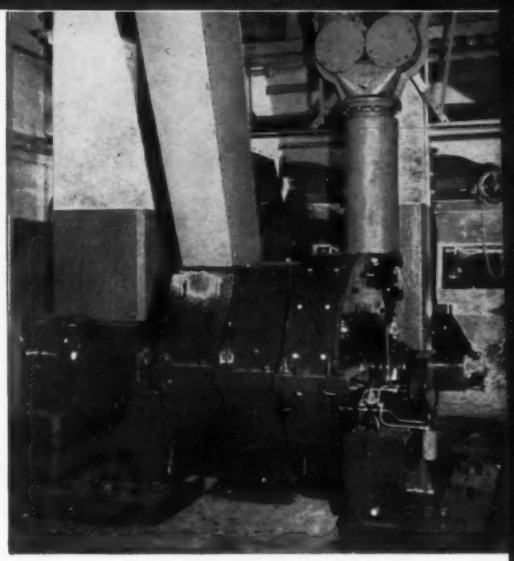
A tungsten carbide faced pulverizing element. Note how carbide completely protects the base.



Shop view of Riley Pulverizer. Left to right: crusher-dryer elements, main pulverizing section and primary air fans.



These six Riley Duplex Pulverizers will supply a 2,000,000 lbs/hr reheat unit at the River Rouge Plant of Detroit Edison Company.



A small #350 Riley Pulverizer installation, typical of hundreds that are operating in industrial power plants with units ranging in capacity from 50,000 lbs/hr up.

Easy on the Nerves!

Ease of Maintenance

All Pulverizer parts are accessible by simply removing top half of housing. Complete replacement of parts can be made in one day. Crusher-dryer parts can be replaced by merely removing separate covers in housing. Bearings for main shaft are only parts to be lubricated.

Ability To Run Without Coal

Because no moving parts are in contact with each other, no damage will occur when operating without coal. Operation is quiet.

Explosion Proof

There has never been an explosion in a Riley Pulverizer under normal operating conditions. Coal travels so fast thru pulverizer that flame can't propagate.

High Primary Air Temperatures Used

Riley Pulverizers operate with discharge temperature normally at 200 F which increases boiler efficiency. Higher temperature aids combustion and lighting of burners.

Ease of Automatic Regulation

Only two adjustments are needed with change of load; (1) coal feed to pulverizer and, (2) air to burners — ideal for efficient automatic operation.

No Auxiliary Air for Sealing

Auxiliary blowers for sealing or for protection of bearings are not required.

Compact and Space Saving Design

Riley Pulverizers occupy the least space per ton capacity of any pulverizer made.

Low Foundation Cost

With no inherent vibration and being the lightest in weight per ton capacity, the foundation does not need to be massive and deep.

Low Power Consumption

Due to the principle of pulverizing in suspension by impact and attrition, power to run Riley Pulverizers is low at all loads.

Ease of Start-Up

The small percentage of primary air, and a uniform distribution of coal from Riley Burners make lighting of burners easy and provide a stable flame at low loads.

Capacities from 3000 lbs/hr to 60,000 lbs/hr

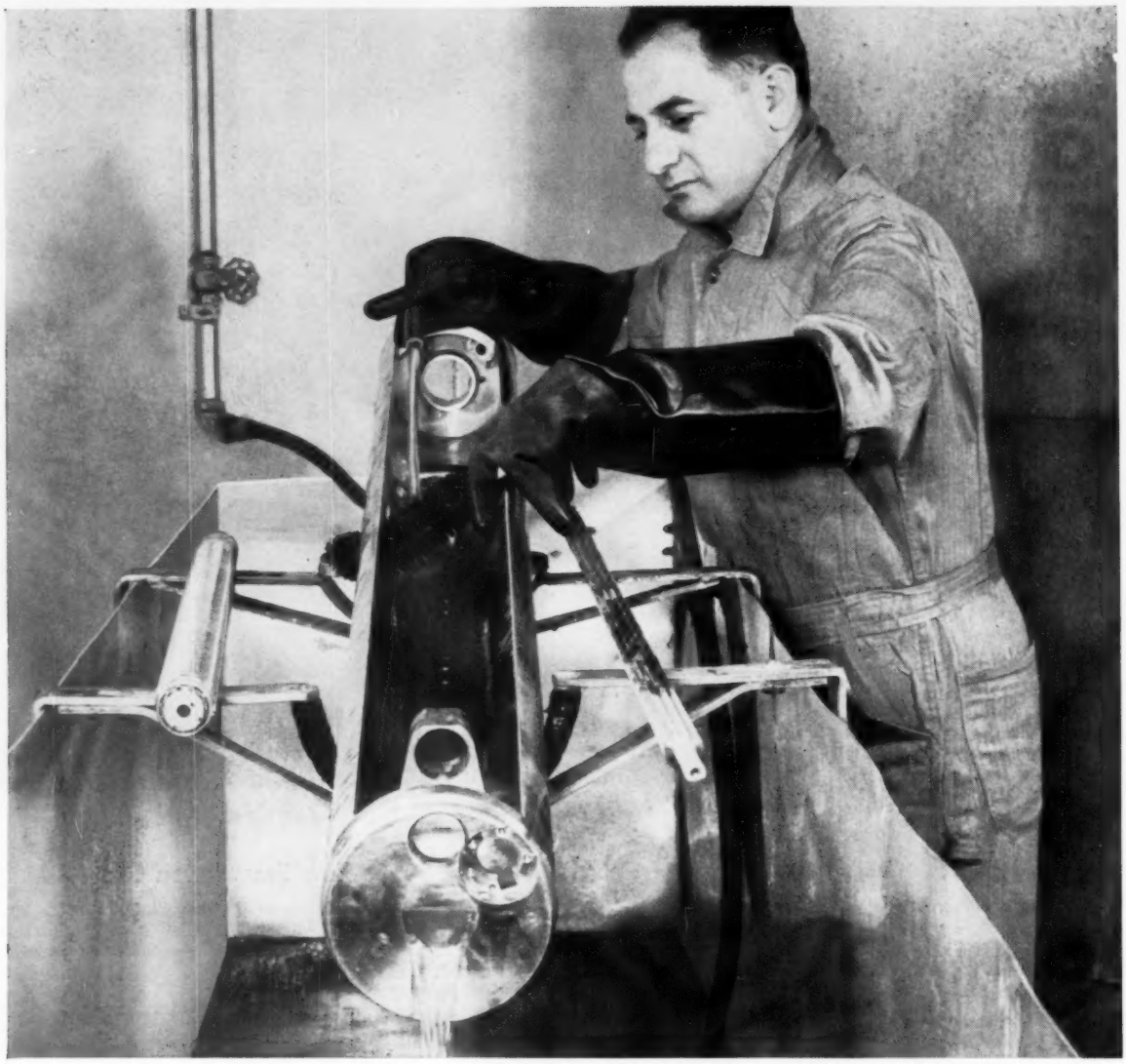
Riley Pulverizers are supplied in a range of capacity suitable for any size of modern boiler.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

For Complete Riley Pulverizer Details Contact a Riley Office in:

Worcester, Atlanta, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Kansas City, Los Angeles, New York, Philadelphia, Pittsburgh, New Orleans, Portland, St. Louis, St. Paul, Salt Lake City, San Francisco, Seattle, Syracuse.



A control rod drive housing being rinsed at Fairchild Camera and Instrument Corp. Radiological Decontamination Laboratory, Syosset, L. I., N. Y.

Ion exchange helps save "hot" reactor mechanisms from the nuclear cemetery

When valves, pumps, heat exchangers and other parts used in or with nuclear reactors became sluggish or clogged, they used to be taken out and buried in the ground because they were radioactive . . and replaced by new parts. This ran into money. A single control rod drive mechanism, for example, costs $30,000.

Now radioactive contamination is actually scrubbed off and rinsed away so that parts can be refurbished, reassembled and re-used . . at a fraction of their replacement cost.

Radioactive rags, brushes and cleaning fluids used for decontaminating are put in special containers and disposed of through licensed agencies.

But the problem of what to do with the contaminated rinse water is easily solved at Fairchild by their Permutit Nuclear Purifier. Each refill of 3 cubic feet of Permutit ion exchanger resin in this unit safely decontaminates thousands of gallons of rinse water!

Other nuclear applications where Permutit ion exchange is employed: concentration of uranium from ore, demineralizing reactor coolant water, treatment of radioactive wastes and purification of heavy water.

Permutit's nuclear experience is at your service. Write to the Permutit Company, Dept. PO-11, 50 West 44th Street, New York 36, or Permutit Company of Canada, Ltd., Toronto 1, Ontario.

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rhymes with "compute it"

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Water Conditioning

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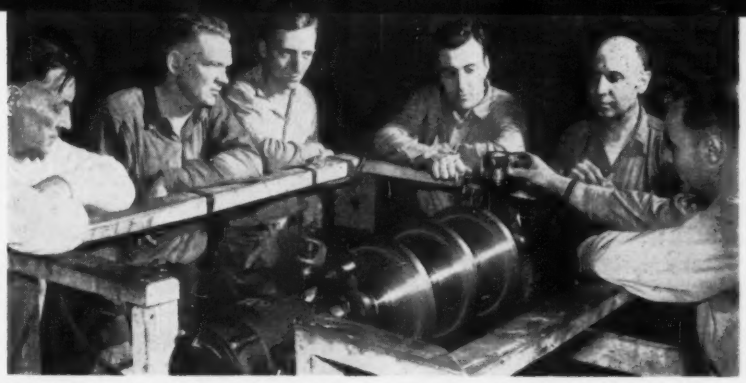
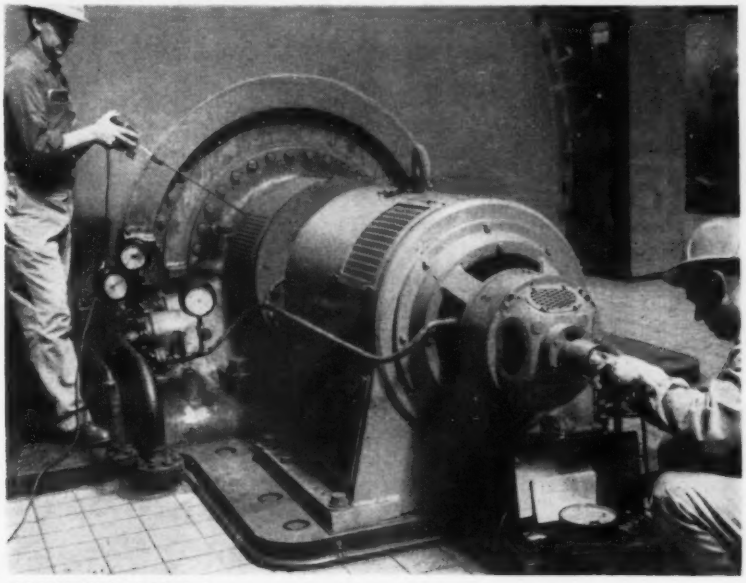
Plant maintenance and management section

STEVE ELONKA
Associate Editor in Charge



TRAINEES in dynamic balancing watch their instructor as he measures bearing vibration



MAINTENANCE MEN, having completed their training, take readings on a large generator

Vibration control of turbine-generators

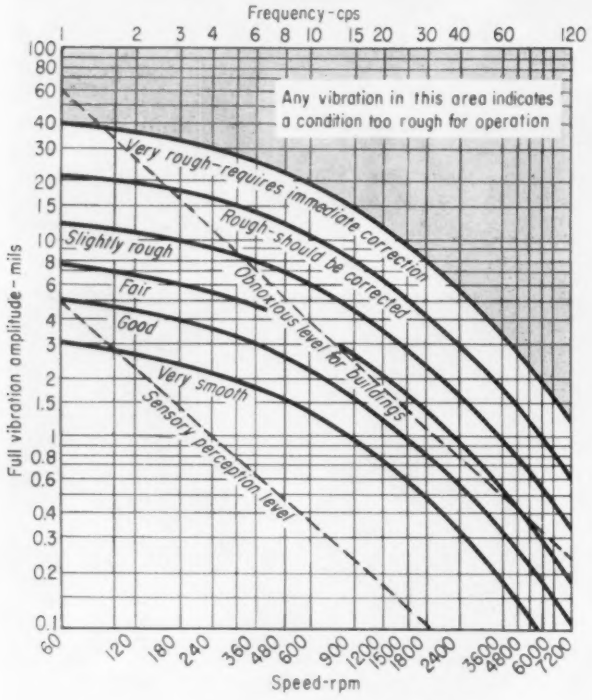
By MAURICE SALVAGE
Senior Production Engineer
Consolidated Edison Co of New York

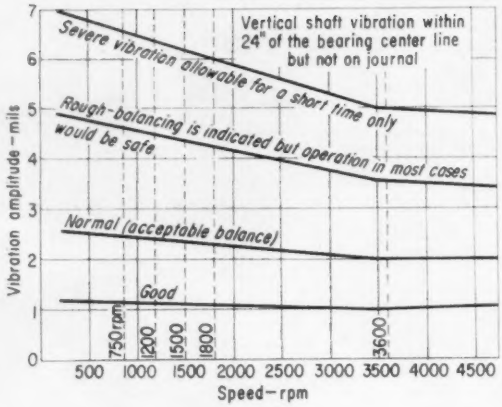
Vibration is energy diverted from a useful purpose to a destructive end. Since it's an expensive nuisance, if you can't eliminate it, reduce it as much as possible.

There's always some vibration in turbine-generators, no matter what care is taken during fabrication and assembly of rotating elements. Remember, while rotors and shafts are accurately machined to be straight at room temperature, they deform when heated to high operating temperatures.

Thermal instability is caused by nonhomogeneity of the material or by steel crystals that mutilate in some sections of the rotors during machining. Some turbine manufacturers make it standard practice to stabilize heat treatment of turbine rotors at rated speed after machining. But some residual thermal instability always remains, causing a small shaft deflection that varies as the kilowatt load changes.

Trouble is that this small deflection displaces the center of gravity of the rotating mass from the axis of rotation. Although amount is perhaps only a mil or less, it becomes a revolving radial force in step with the machine's speed. Added or subtracted from the rotor's





COMPANION CHART shows shaft vibration tolerance. Like first, it's only a guide since tolerances are rigid

FULL AMPLITUDE indicated on the ordinate is the double amplitude or the distance from peak to peak

You need alert, carefully trained operators

static load it causes the elastic bearing structure to bend by a variable amount. This, in turn, increases and decreases the static deflection once each revolution. When the resulting motion is measured up and down, it's termed *vertical vibration*. There's an infinite number of planes through which the vibration of a machine can be measured. But, in practice, the measurements are limited to (1) vertical plane (2) horizontal plane transverse to the axis of the turbine and (3) axial plane.

Since you can't completely eliminate vibration, you ask: "How much vibration can I tolerate without endangering the equipment and causing costly forced outages?" Because of varying designs of both turbine-generators and their supporting structures, this question has no exact answer. Besides, when referring to vibration tolerances, you must state whether values are for machine's shafts or bearings, as the two have different tolerances.

Exciting force (or forces) causing a structure to vibrate originates in the rotating elements. It is transmitted through the shafts to the bearing, then to the structure. So the logical point for vibration measurement is on the shaft itself. But, since this isn't convenient where shafts aren't visible, the bearings are the most favored locations for measuring vibration. Keep in mind that shaft vibration, which is the motivating force behind the vibration of the bearings, can be from three to ten times higher than that of the bearings.

Tom Rathbone of Fidelity & Casualty Co of N. Y. came up with a chart that we have adopted at Con Ed for bearing measurements. Full amplitude indicated on the ordinate is the double amplitude or the distance from peak to peak of the vibration. Another chart, originated by Westinghouse Electric Corporation, is a companion piece for determining shaft vibration tolerance.

Both charts are only guides since tolerances shown are extremely rigid. Usually these tolerances are difficult, if not impossible, to obtain. They do represent a goal: If attained for turbine-generators, these tolerances can contribute to long periods of trouble-free operation.

Amplitude by itself doesn't give enough information because vibration can be either harmonic or nonharmonic. Example of the latter: the summation of several frequencies of lower or higher order which can be complicated by a chattering motion caused by impactive forces from looseness somewhere in the machine.

Only in case of simple harmonic motion is the acceleration of vibration also harmonic. Otherwise acceleration isn't proportional to the displacement of vibration amplitude. Thus, for equal vibration amplitude the machine vibrating in a simple harmonic motion can be entirely satisfactory. But if this motion isn't harmonic it can be intolerable. So you can see that besides charts and figures, you must consider each case individually using experience to appraise and correct the vibrations.

For many years Con Ed has been keenly vibration conscious. A small group of employees in each station

is trained to measure, analyze and make corrections. Our 54 turbine-generators, in six major stations, range from 10 to 335 mw to supply peak distribution loads of as much as 3500 mw. Load ratio between day and night is 4:1, requiring numerous units to be shut down nightly and started the following morning. Since this is about the toughest operation you can face, we originated and developed controlled starting of boilers and turbines in our company. It minimizes the thermal stresses during startup. And it's these transient thermal stresses that account for much of the permanent damage affecting the unit's balance.

Balancing. If important repair work has been done, we balance the rotors of a turbine-generator after every overhaul. The job is done at low speed and at room temperature. Either a Trebel or an Akimoff dynamic balancing machine is used, depending on the rotor's weight. These large balancing machines are available at two nearby shipyards. Thus, we correct any serious unbalance that might exist in the rotor and that could destroy (during initial start) the close internal clearances laboriously and expensively re-established during the overhaul.

In each station there's at least one resident staff member in the production department who has received vibration training. He learned his job from instruction sheets and by actually balancing turbine-generators in the field. We have found this setup permits us to schedule both personnel and machines for balancing jobs to fit in with our system load requirement. We don't have to rely on availability of manufacturers' specialists.

Two instruments are used in each station to check the condition and to balance a unit. First is either an Askania or a Davey vibrograph, second is the Westinghouse type HQ portable balancing set.

If vibration after overhaul and shop balancing isn't satisfactory, the staff man takes over and completes the balance in the field. Therefore, when the unit is finally declared ready for service it's in its best mechanical condition and in the best possible balance. At this point, a set of vibration readings is obtained which includes: (1) wave shape of vibration at each bearing taken with a vibrograph (2) vibration amplitude and its phase angle measured with a balancing set. These data, which represent the physical condition of the unit, are included in the overhaul report and become referenced data. Their characteristics should remain unaltered if no change occurs in the machine.

From then on the machine is under the care of our production operators, who supervise a group of units. Each new machine has an instrument that continuously records the bearing vibration or portion of the shaft adjacent to the bearings, depending on machine's make. Shaft vibration pickups are now specified for future installations. Some older units having bearing vibration recorders are being changed to shaft vibration pickups.

On our 3600-rpm units, a Frahm resonant reed tachometer ranging from 1000 to 4200 rpm is provided. Object of this tachometer is to inform the operator if vibration is at the unit's running frequency or lower. This information is important. Often, a 3600-rpm unit has bearings that become unloaded due to changes in elevation caused by a sagging structure. This can result in an oil-whip characterized by a vibration at about one-half the machine's running frequency.

Readings. Frequent physical contact is the best way to become acquainted with the unit and its vibration pattern. So our turbine operators take vibration amplitude readings on the vertical, transversal and axial planes of each bearing once each watch. They use a portable dial gage vibrometer, and log their readings. Only precaution is to take readings at a reasonably steady load. At day's end, and if the machine has run 24 hours, the nine readings of each bearing are averaged to yield a single value. This is easily and rapidly plotted on duplicate copies of the log form. Bearing numbers are identified on this form by different colors. On the right, a *vibration gage* is printed which shows the same bearing tolerances given in the first chart, but plotted on Cartesian instead of logarithmic coordinates.

At the end of the month, plotted daily vibration amplitudes appear as jagged lines, depending on care and accuracy in taking the data. But this isn't too important; what counts is trend of vibration amplitudes. Time needed for readings and plotting isn't over five minutes per bearing—it's time well spent. Original chart is sent to the station superintendent; duplicate copy goes to the main office, where it's compared with previous reports to determine if any gradual change in vibration is taking place.

If the turbine-room operator notes any sudden vibration change, he notifies the production staff engineer. The latter immediately takes a set of wave shapes and bearing amplitudes, together with their phase angles, and compares them with the reference data taken after overhaul. He then analyzes the vibration and develops specific recommendations for correction. If necessary, he opens or balances the machine.

Analyzing vibration and balancing turbine-generators is an art. If simple unbalance such as breakage of a blade is causing the vibration, there's usually little trouble in balancing the unit. This is especially true if the man doing the balancing has had experience with the response of the machine to balance weights.

But there are many reasons other than simple mass unbalance that cause a machine to vibrate. Much of the balancer's skill is shown by his ability to decide upon the proper course of action when balancing proves ineffective to correct the condition.

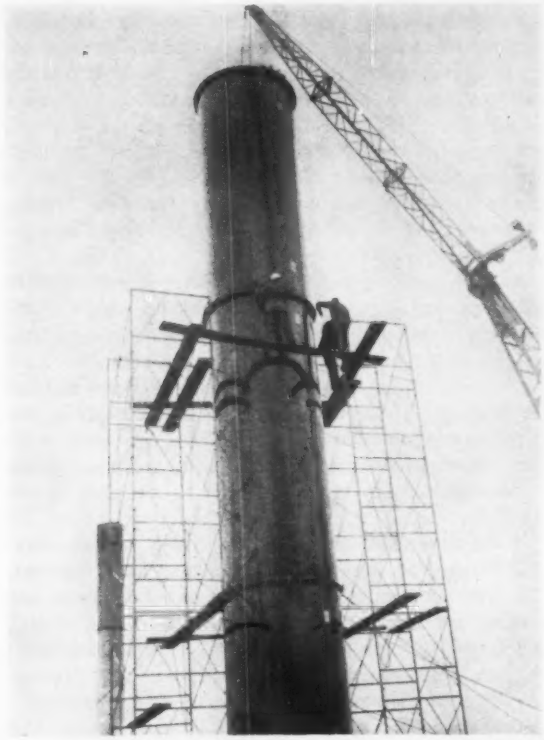
Frequency of balance corrections varies for different units. In some stations we have generators which are air cooled by open ventilation. This results in the progressive accumulation of dirt in the stator and field windings. On such units balancing is frequent and takes as much as 25% of the staff engineer's time. In other stations balancing moves are rare.

Training. Other than the instruction sheets previously mentioned, we don't have any formal means of education. When tackling a balancing job, each qualified staff man is assisted by a young trainee who eventually acquires the experience necessary to proceed on his own.

It's worth repeating that the practical ability to analyze and correct vibration is the fruit of long experience. We feel our program of vibration control is good. It has justified itself by maintaining our units in proper running condition at the best possible efficiency.

OPERATORS' NOTEBOOK 123

Today, glass coating



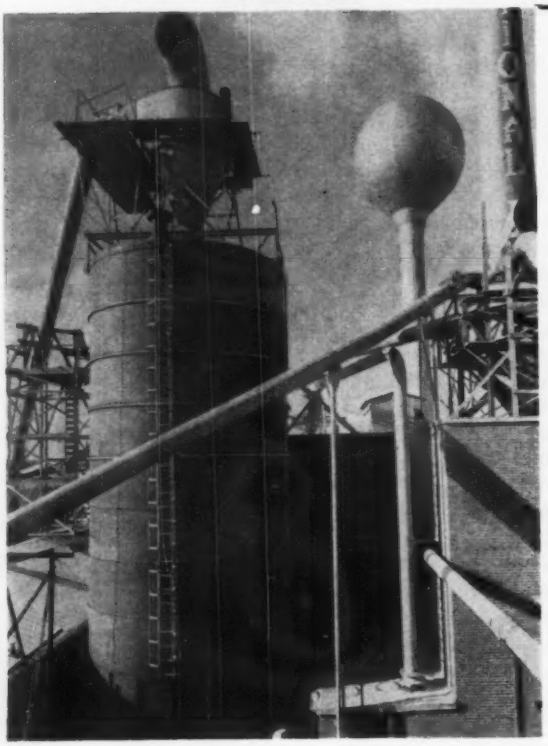
All-steel smokestacks are coated

You plant engineers may not know that 95% of all unlined carbon-steel smokestack failures are claimed to be from inside-the-stack corrosion. Only 5% of this waste is from outside atmospheric conditions.

Now, stacks are glass lined, inside and out, to give 3 to 5 times more life. Corrosion-resistant glass is fused to steel, forming an armor that copes with accelerated corrosion found at low flue-gas temperatures.

Flue gas passing up the stack may be cooled to about 300 F or less. Then entrained moisture in gas is condensed out. Because natural gas, fuel oil and coal contain varying amounts of sulfur, the resultant sulfur-dioxide gas dissolves in the condensate to form sulfurous components. Deterioration is most common in the upper part of the stack where low temperatures and condensation is most common.

Glass, fused to steel, offers outstanding protection against acid attack. The glass coating weighs about 5 oz per sq ft (inside and out) compared with conventional linings of up to 50 lb per sq ft. So foundations or sup-



Glass-lined storage tanks have a

Storage tanks are also glass-lined to reduce corrosion. Present-day units are for a wide line of products including wood refuse, sawdust, soda ash, flour, rice bran, malt, feed ingredients, dextrose, pearl starch, materials for plastic manufacture and many other products.

These tanks are more than just empty storage containers; they are unique, mechanized, bottom-unloading bulk-storage systems made of preformed panels, and are produced in sizes from 14 to 20-ft diameter with heights from 10 to 50 ft (in 5-ft sections).

Special formulated coatings protect the exterior and interior plate-steel panels. Tank sections are bolted together with cadmium-plated steel nuts, washers and bolts, against asbestos spacer washers. Space between each section is sealed with asbestos type mastic gasket material. These tanks also are midnight blue in color, and need no maintenance.

Adaptable to limited spaces, the tanks are constructed for the most part on a concrete base containing a trough that accommodates the mechanical unloader.

cuts corrosion of steel

By STEVE ELONKA, Associate Editor

inside and out with midnight-blue glass

porting steel costs are much less for glass-lined stacks. Tests also show that glass linings resist abrasion.

A disadvantage of unlined, plain steel stacks is that interior corrosion is hidden and cannot be stopped by any of today's organic coatings. Repeated painting of the exterior merely conceals the stack's true condition, and unexpected failures may occur at any time. Too, excess metal thickness over code requirements for corrosion allowance, extra weight and foundation needs add to initial cost, while giving doubtful security. Thus, low initial cost is many times outweighed by these factors.

Trouble with ceramic-lined steel stacks is that exterior surface needs maintenance every two or three years to prevent corrosion and poor appearance. Maintenance is also needed on interior to stop flue gas from seeping behind steel lining and causing hidden corrosion.

What is glass lining? More than 15 ingredients are blended at 2400 F in a smelter. Molten glass is poured into running cold water which solidifies the glass, shattering it into tiny glass particles that are designated *frit*.

For lasting fusion with glass, the steel surface is sandblasted to remove all dirt, oil and foreign matter. This also roughens and provides more square inches of glassing surface. The tiny particles of glass are finely ground with clay and water, resulting in a homogeneous liquid mixture called *slip*. Slip is then sprayed on the surfaces of the stack sections and dried at ambient temperature. The slip-coated stack section is fired at 1650 F in a furnace. This firing process, which inseparably bonds the glass to the outside and inside steel surfaces, produces a bond strength of 10,000 psi.

Resultant coating is tough, smooth and lustrous. But the glass is so flexible that it bends with the steel as long as there's no permanent deformation of the steel. In a lab test, after flexing a stack section more than 2¼ million times by compressing it from 8 ft to 6 ft 8 in., the elastic glass showed no signs of imperfection.

Another advantage of glass-coated stacks is their midnight-blue coating. This is a great improvement over drab smoke-stained stacks that dot our large industrial areas.

bottom feeder for handling bulk materials

The unloader rotates from a center post, which sweeps in a full circle, cutting a swathe about bottom of the bin.

A chained claw mechanism operates along the unloader arm, drags material toward the center chute as the arm circles. Materials fall free to the trough and are swept by the chain and clasp conveyor system that feed either into the system or to discharge, depending upon the particular needs of the plant.

Most users have hooked up their storage systems to the vertical glass-coated bins to create a totally enclosed operation. Air entrainment, utilizing standard pneumatic materials-handling systems, is highly popular today. One big advantage of the glass-coated storage bins is that they can be teamed with such materials-handling systems. And flexibility of their mechanical sweep-arm bottom loader allows a hookup with other conveyor-feeding arrangements, making possible a completely automatic system. This is claimed to be the first workable method for feeding out tons of free-flowing and semi free-flowing bulk materials. It's also a major improvement over the first-in, last-out storage bin loading systems.

Too, it assures feedout discharge of in-bin materials in the same order that the bin was filled. Thus the system eliminates need for bin-shaker devices to break down handups. Rocker sweeping-arm action prevents accumulation of stagnated materials. Present range for pneumatic systems is for materials as fine as 400 Tyler mesh to course crystals up to 1½ in. diameter.

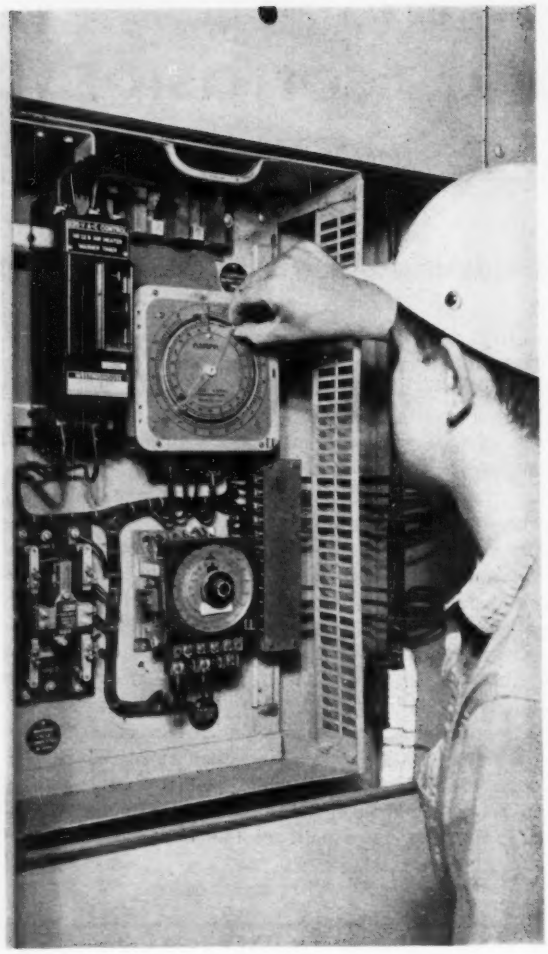
Applications. The systems are used in wood mills both as a feeder storage and feed system for scrap feeding boilers. They can be used to handle wood chips to be processed into pressed board, and for coping with such tight packing materials as talc and flour. In these and many other cases, the system is an economical improvement for handling bulk materials.

A survey showed that some 20% of the present bulk-storage tank users store finished products such as feed grain urea to malted milk. Reason: There's no contamination from the smooth, clean, glass lining inside the unit.—*Courtesy, A O Smith Corporation, Milwaukee, Wis.*

By W C AMES
Superintendent, Linden Generating Station
Public Service Electric & Gas Co

Automatic washing cuts air preheater cleaning problems

New water washing system at Linden Station reduces our manpower requirements, need for extended low-load operation, by cleaning horizontal air preheaters in off-peak hours



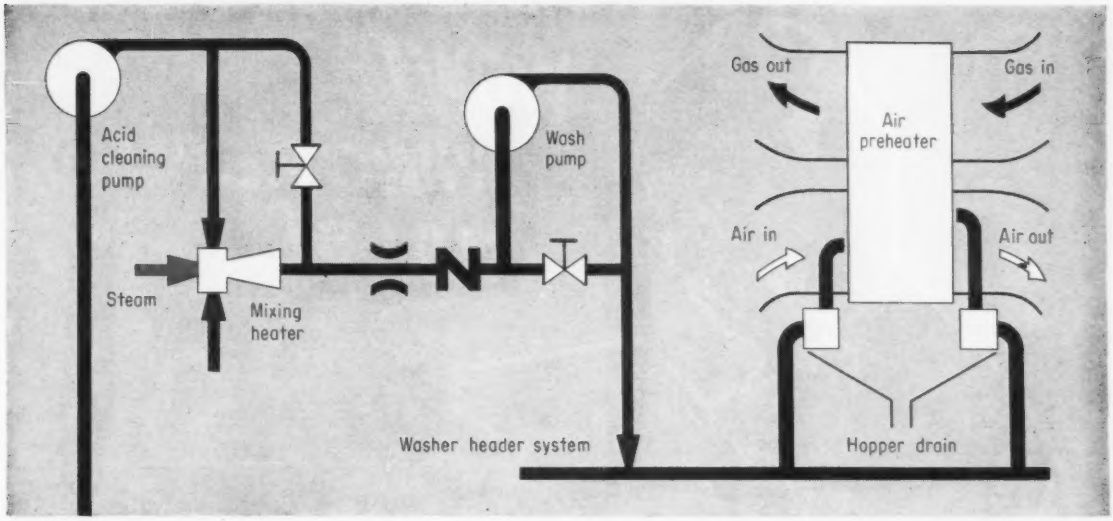
AUTOMATIC TIMERS control washer nozzle speed and time lag of second element. Operator resets timer speed as wash progresses

Water-washing horizontal shaft air preheaters with boiler in service is a regular practice in our Linden Generating Station. Washing technique was developed along lines prepared by Air Preheater Corp engineers. Public Service operating engineers adjusted and refined washing procedure so we now have a method of maintaining preheater cleanliness without heavy manpower needs or scheduling extended low loads or outages.

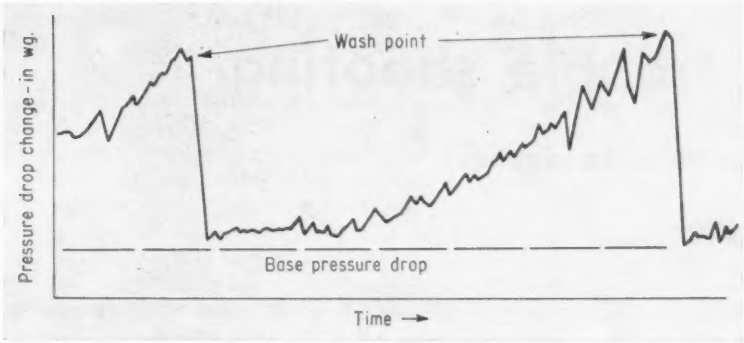
Cleaning horizontal shaft air preheaters has been a problem in the past. So, when Linden Station was in design stages, we approached the problem of preheater cleaning with caution. We got one solution to our problem when Preheater engineers outlined a new technique for washing horizontal units in service. After discussion, we decided to install washing equipment on all preheaters as recommended initially by manufacturer.

Washing system has semiautomatic cycle for each preheater, allows washing one preheater at a time. Washing cycle runs during off-peak hours of 12 pm to 8 am, when unit load allows isolation of one preheater. High-velocity water nozzles in preheater air inlet and outlet give effective cleaning from both directions. Plant filtered water is heated to 180 F by steam injector and pumped at 200 psig to the two nozzles. Washing action consists of continuous, high-velocity jet spraying as nozzles track across radius of preheater. Automatic timers control nozzle tracking action, and delay air inlet washer nozzle starting so nozzles are not aimed at each other. During washing period we use preheater air motor drive to allow speed adjustment. Timers and preheater air drive are adjusted to correct for inherent speed variations in nozzle positioner.

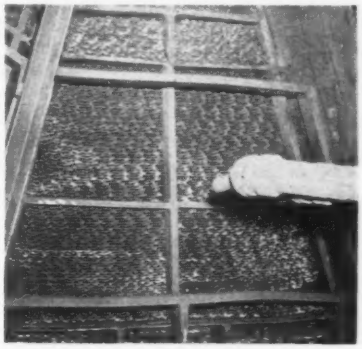
As washing cycle progresses, periodic checks of drain water pH tell us how effective the wash has been. At start of a cycle, drain water runs around 2.6 pH. Readings gradually increase during wash period. In addition to pH measurements, we use visual inspection and pressure drop readings to check wash effect. Visual inspection with boiler in service can only spot missed sections. Deposits lodged deep in the elements must be



WASHING SYSTEM connects single pumping station to headers supplying all preheater washers. Headers and pumping station are shared with acid-cleaning system. Nozzles at preheater air inlet, outlet give staggered, two-direction washing for maximum cleaning



PREHEATER PRESSURE DROP increases as elements become dirty. Running plot of increase helps operators catch fouling condition before unit performance is affected



WASHER NOZZLE directs high-velocity jet through elements as it moves along radius

picked up by inspection during outages. We keep wash water flow high since deep deposits can only be removed by large amounts of water.

Pressure drop readings are our final check of wash effectiveness and also our yardstick for deciding when to wash again. Following each washing, preheater pressure drop is measured and compared to a base figure for a clean preheater. Additional checks are taken each day, and a running plot of resistance change used to measure fouling. Through our running plot we catch fouling conditions before they affect unit operation. At the same time we wash only when needed, rather than follow an arbitrary cleaning schedule.

Preheater washing with gas and air flow through the heater is not a normal routine, but we did get experience with in-service washing of one unit. When first boiler went into operation we ran at 2/3 load with one preheater in service. This meant our washing system had to successfully clean without a load drop. Happily, the technique was a success, and we kept the boiler up at load. As soon as two-heater service was possible we stopped washing with preheater in service. We did this after noticing duct corrosion resulted from highly acid slurry blowing into duct sections where it couldn't be cleaned out.

During the first few washings we tried various modifications to the original technique. Initial washes used alkali solutions, but operating experience did not indicate any advantage to this method. Caustic required to neutralize deposits was tremendous, and value for corrosion inhibition was questionable. Later washing cycles used filtered water.

We are still experimenting with washer nozzle design in an attempt to further shorten time required for one cycle. Satisfactory washing depends on nozzle's ability to direct a high velocity stream, which will overcome gravity pull and carry through elements. Effective washing also requires large quantities of water, and to speed up washing cycle, we need a nozzle which will give high velocity and increased coverage. We hope improved nozzles will allow us to clean one preheater in four hours.

Refrigeration trouble shooting

How would *you* cure these three headaches?

By C T BAKER, Atlanta, Georgia

You can't be in the consulting business as long as I have without wondering why business people insist on throwing away buckets of money. In the refrigeration and air-conditioning fields, this comes up daily. It's usually caused by trying to save a few dollars on original installation. When will top management learn that the cheapest installation is often the most costly in the long run? I've asked myself that question a thousand times, but I don't have the answer yet and probably never will.

The three cases given here are typical. To save a few dollars, jobs are piped poorly, important equipment is left out, or the contract is given to someone who knows little about engineering. Many of these headaches could be avoided by calling in a consultant who has made a reputation for knowing his business. Hiring a good consultant is usually the best investment that management can make—especially if they know nothing of refrigeration and air conditioning.

CASE No. 1—Ammonia in Freon plant?

The owner of a combined dry-cleaning and fur-storage plant called me one hot July day last year. He was afraid about damage to furs in his storage vaults from effects of ammonia.

The plant had two 7½-ton Freon-12 compressors and the usual arrangement of condensers, evaporators, piping and condensing water-circulating pumps.

When I visited the plant, the owner told me that he had no ammonia equipment—only Freon refrigeration was used. There were two fur-storage vaults. One was filled with furs; the other had been emptied recently. Inspection of the room stored with furs disclosed an interesting situation, to say the least.

The plant had been built at the tail end of World War II, when insulation was very difficult to obtain. Because management could not delay completion of their fur-storage rooms until an acceptable insulation material could be obtained, they compromised and agreed to use hog hair. This material was made into boards and applied to the wall and ceiling surfaces of the rooms in an adhesive compound.

For a time things went well. There was no problem in maintaining the desired storage temperatures and humidities. But, after six or eight months, a strong ammonia odor was noticed every time the vault doors were opened. This condition grew worse until, finally, the owner became uneasy. He knew that ammonia in contact with furs would eventually harm them.

Insulation on the ceiling showed large splotches of white (like skin over a blister). When pierced with a sharp tool, water poured in a stream to the floor. This condition was found to be quite general over the ceiling surfaces and on the upper part of the walls. Of course,

the water was from moisture transmigration through the walls and ceiling from difference in vapor pressures between the inside and outside of the rooms. When condensed in the insulation, this moisture set up a reaction with the treated hog hair. In time it produced a strong odor, such as you would expect from a leak in an ammonia refrigeration plant.

Just what this product was I don't know, as none of the condensation was analyzed to determine what it held in solution. Besides, it wasn't important.

Further investigation disclosed serious disintegration of the hog-hair insulation. I felt that only solution was to completely remove this material from the walls and ceilings of both rooms. Two inches of vegetable corkboard was applied after the surfaces had been backplastered. That gave the necessary insulation.

This has completely eliminated the ammonia problem. It has also reduced the running time of the refrigerating compressors since heat leakage into the fur-storage vaults has been lessened. Their plant now operates efficiently.

CASE No. 2—Ignorance or dollars?

In four instances within the past few years, I have investigated cases of compressor troubles that the owners were most anxious to have cleared up. Two were compressors used in ammonia refrigeration plants and the others were Freon-12 comfort cooling plants.

Trouble occurred in each case when the compressors were automatically started by the thermostatic control as the temperature called for compressor operation. Following startup of the machine, it took 30 to 40 minutes for the compressor to settle down to quiet operation. Then it remained vibrationless through the rest of the cycle.

Investigation showed that in each case operation was started with the compressor cylinders flooded with liquid from the evaporator. Question was, "Why were the evaporators full of liquid?" Answer gave evidence that the contractors who had installed the equipment were either ignorant of cause and effect, or were money-grabbers and had no scruples about chiseling. None of these compressors had solenoid valves on the liquid line to stop flow of liquid refrigerant to the evaporator when the compressor stopped.

Solution in each case was to install a solenoid valve on liquid line to open and close simultaneously with starting and stopping of the compressor.

Who paid for the investigation and subsequent installation of the control valve? The owner, of course, because the contractor very carefully explained that this valve was not specifically called for in the contract between the buyer and seller. Were the buyers in these transactions satisfied? Far from it—and they tell others how they were gypped. So the contractor also took a beating here.

In this ammonia refrigeration plant, the discharge piping between the compressor and condenser often cooled to point that flanged joints contracted so much that leaks occurred, resulting in loss of refrigerant.

If ignorance prevents a contractor from installing a solenoid valve on a liquid line, then he should try some other means of making a livelihood. And if the dollar prompts such practice, I believe he should be jailed.

CASE No. 3—A $5500 headache

During 1948, an experienced ice manufacturer built a small plant to serve an area that would normally take the output of the 15 tons that the plant was designed to produce. But after a few years of successful operation, the owner sold the plant. The property was in good physical condition. At the time it was producing rated capacity.

Investigation. In July of this year I was called in to investigate the plant. The new owner couldn't understand why power costs were so high, or why production was down to 10 tons per day instead of the 15 tons anticipated. After finding the trouble, I was also asked to estimate the cost of putting the property in shape to produce capacity and lower production costs.

Here's what I found: (1) Plant output—9 to 10 tons of ice per day (2) condensing pressure—230 psi (3) suction pressure—unknown (no suction pressure gage in the plant) (4) power consumed per ton of ice produced—105 to 110 kwhr (5) power cost per ton of ice produced—$1.35 to $1.40 (6) ice formation on freezing tank coils—resulting from drippage of fresh water into brine from melting frost on uninsulated suction piping and float accumulator (7) leaking compressor valves and pistons—reflected by excessive superheat in discharge gas (275 to 290 F) (8) evaporative condenser fan motor changed from 3 hp to 7½ hp (9) fan speed—increased beyond all reason.

As a whole, the plant was unbelievably dirty and unkept. The 50-hp slip-ring motor driving the compressor was running dangerously hot. Oil drain valves on both the h-p oil trap and on the oil drain connecting to the bottom header of the freezing tank coils were inoperative.

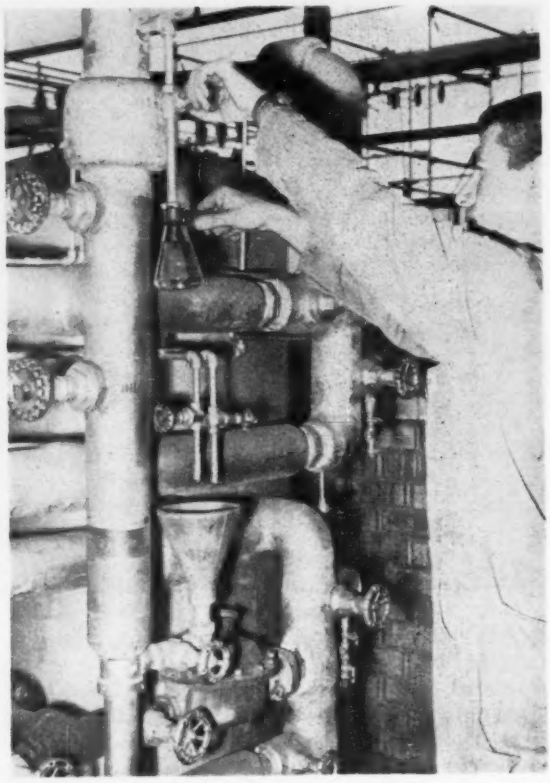
Plant engineer had concluded that he could reduce the excessive condensing pressure by speeding up the fan that supplied air to the evaporative condenser. So he installed the larger fan motor, previously mentioned, using a large pulley on the motor shaft. No one knew at what speed the fan was running. But judging from the roaring noise at the air and water vapor outlet, the increased speed was far beyond any sensible value. While not specifically determined, it was evident that the static resistance at the air outlet was greatly beyond that for which the fan was designed. So the power consumption was greatly in excess of the original 3-hp motor.

Condenser coils were heavily coated with soluble solids from the spray water. No provision had been made for continuously drawing off a quantity of water from the condenser basin to keep the concentration at a minimum. Moreover, condenser-water basin had not been emptied or cleaned in two years. So dirt and deposits left behind by the evaporating water gave the contents of the basin the appearance of soup.

Cost of repairs. My conservative estimate to put the plant in shape to operate economically was $5500. Major items included a new condenser, reconditioning the compressor and installing a new compressor motor.

This is quite a sizable addition to the capital investment in a small ice plant. Like the "Decay of Rome," the whole story was neglect in properly maintaining the plant. But don't think that this lack of good business practice is reserved to the ice and refrigerating field. In my work I find it in many business spheres almost every day.

BY F E ZIEGELMANN
Powerhouse Engineer
Delco-Remy Div
General Motors Corp



COLLECTING SAMPLES this way was too time-consuming. So we piped all samples direct to test sink, cut time of job by 50%

Hot-process softening calls for a lot of legwork in running water analyses. Here's a plant that piped samples to a central point and revamped their test bench. Now they . . .

Sample and test water the easy way

Revamping our water-sampling method paid off big dividends—it trimmed time needed to do the job by 50% and turned a messy chore into a neat, clean operation.

First we ran lines from all sampling points to the rear of the test-sink cabinet. Makeup is treated in a hot-process softener, filtered, and residual hardness removed in hot-zeolite softeners. Samples of water include those taken from the filters, hot-process and zeolite units as well as plant circulating cooling water and condensate return. Now all samples are drawn right at the sink. This was the main time-saver since it cut out need to walk through the plant collecting samples.

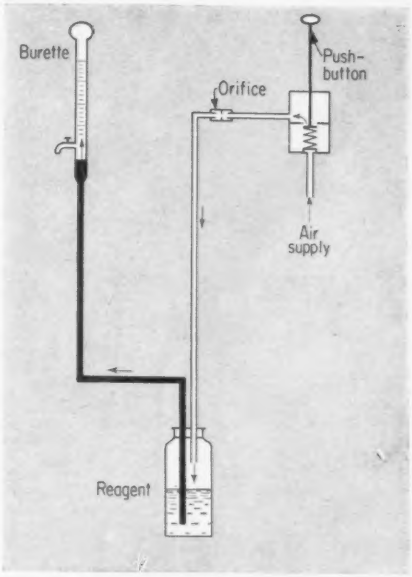
Sample lines feed to four taps placed just below the sink faucets. Although there are more lines than taps, a piping arrangement enables us to collect whatever samples we need by simply turning the right valve in the back of the cabinet. Setting up the system took some material and man-hours, but was worth the trouble—cost of the job was tiny compared to the labor we'll save each year by using the new technique.

Renovation also included the sample coolers. Since coolers weren't big enough for the job, feedwater flowing out the sampling petcock was too hot and some flashed into steam when pressure was released. Therefore we couldn't get a true sample. And method was an accident hazard—we really needed the handles on the Erlenmeyer flask used above.

We licked that problem by making our own coolers and attaching them to the rear of the cabinet. This simplified the cooling arrangement since we could pipe all water for the boilers to one convenient spot. Samples now feed directly from coolers to the taps.

Coolers were made from ¼-in. copper tubing, short pieces of 3-in. pipe, a section of 2-in. pipe, and some odds and ends. We worked up two by wrapping 35 ft of tubing around the 2-in. pipe, stuffing the coil into a jacket formed by the 3-in. pipe, leading both ends of tubing out the top of the jacket, then welding jacket ends shut. Holes drilled into the jacket wall admit cooling water; the sample passes through the tubing.

A third cooler, which works much better than the first two, differs only in that tubing is led out both ends of the jacket. Sample enters the top and coolant goes in the bottom. We use this one for cooling the boiler-water sample, since it does the best



Push button, burette fills. Secret . . . Air flow forces reagent upward

Here's another case of putting air to work, and right handily, at that. Photo shows water analyst pushing a button, left hand, to fill burette—diagram indicates how system works. The button is actually the top of a long rod resting on a spring-loaded ball check valve. When ball is depressed, low-pressure air passes on down to reagent bottle. An orifice in the coupling limits air flow so burettes don't fill too fast and bottle corks stay put. When enough reagent has been pushed into the burette, button is released. With air flow to bottle stopped, pressure bleeds from system, and excess reagent drains from burette to reagent jar.

with a "semiautomated" lab setup

job of our three homemade coolers.

Once the collection system was straightened away we went to work on the test bench. With all the paraphernalia needed to make the analyses, the sink area looked like a junior glassblower's workbench.

Correcting the situation was simple. A large piece of plywood, some brackets and clamps did the trick. We mounted the board at the rear of the sink after attaching hardware conveniently. It holds small reagent and indicator bottles, graduated cylinders and other glassware. Now testing goes along with a minimum of fuss and bother.

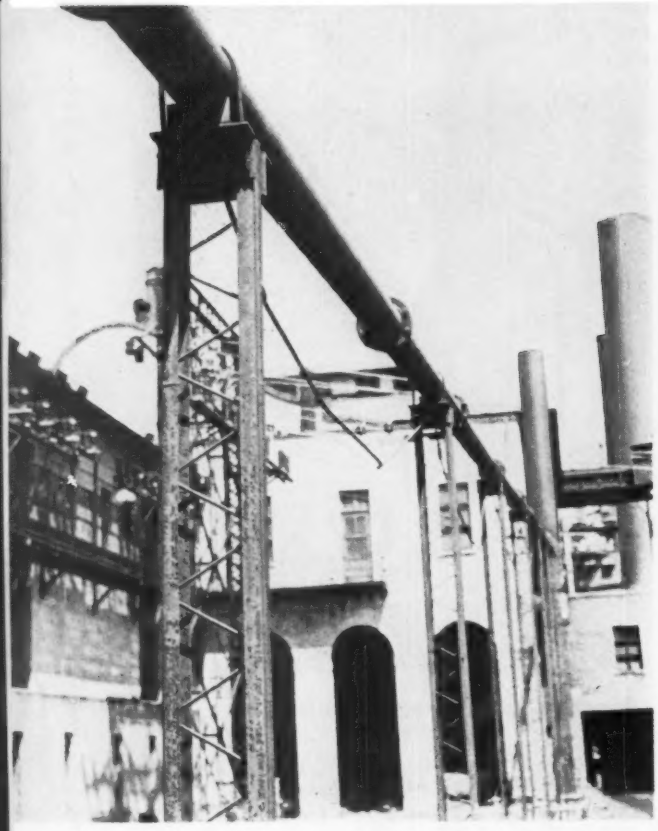
Installing pushbutton control of the burette filling procedure was the final step in revamping the test area. Applying "semiautomation" to the lab not only made work easier, it saved time. Our analyst now has to handle large-size reagent jugs only twice, when they come in and when they're empty. A further advantage: pushbutton method keeps costly glassware out of harm's way. Normally burettes are part of a stopper assembly placed on a small reagent jar. The package is an unwieldy affair: it sticks up in the air, is easily tipped over,

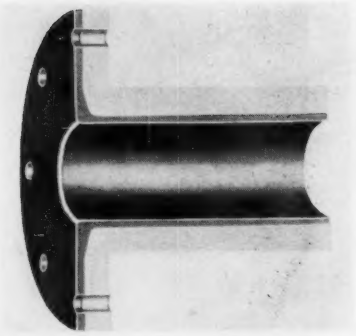
Pushbuttons placed flush with the sink shelf are the tops of copper tubing push rods. Rods operate spring-loaded check valves that are part of a low-pressure air line leading to reagent bottles under the sink. We screwed the valves into a pipe and tee manifold and attached it to the cabinet back.

After making up the manifold, which distributes air to the right bottle, we put a hose-pipe union between it and the main air line. The union contains a disk drilled to restrict air flow to the bottles. Trial and error was the only way to find the right size orifice so that excess air pressure wouldn't blow out the bottle stoppers (drill no. 60 was our answer).

Tubing connecting bottles to burettes completes the setup. Pressing the button allows air to force reagent to top of burette; when released, pressure bleeds off and excess fluid drains back to bottle.

Result of our work showed us that redesigning and modernizing plant equipment and work areas doesn't have to center about expensive, complicated equipment. In our case some piping, labor and thought changed the traditional approach and gave us a good water test lab setup.





2 Rubber lining for Cos Cob ash system is molded hard rubber with integral flange facing. Lightweight lines allow turning sections up to 200-ft long as a single piece

1 300-ft line at New Haven Railroad's Cos Cob power plant carries water and ash mixture to settling basin. New rubber-lined steel pipe outlasts cast-iron pipe 3 to 1

By L E STEWART
Assistant Editor

Rubber-lined pipe trims maintenance

Ash-system maintenance has long been a headache in coal-fired power plants. And ash-line erosion in air or water conveyor systems can cut piping life to less than six months if lines aren't rotated to distribute wear. Rotation of heavy cast-iron pipe is costly; replacement of elbows and joints which can't be rotated is even more so.

Makers of rubber-lined pipe and fittings have an answer: Special pipe is lined with combinations of hard and soft rubber, depending on manufacturer and service requirements. Bends are handled by (1) standard fittings lined with rubber (2) flexible pipe (3) special fittings incorporating replaceable wear sections. System joints vary, but majority are based on a standard flange connection. All types share advantage of resistance to corrosion and erosion, easier installation and maintenance.

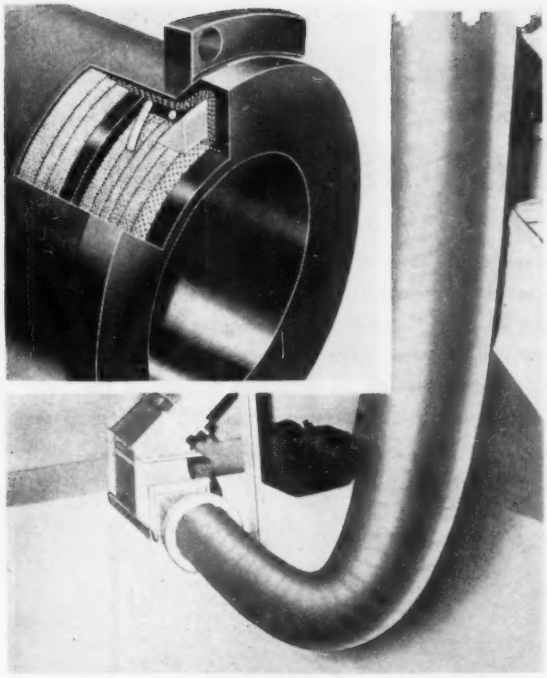
Flexible-rubber pipe offers big advantage for complicated systems and plants with vertical runs or multiple bends: It goes where you want it, eliminating fabricated bends, leaky joints, possible relocation of equipment to allow straight runs of steel pipe. Use in bend sections allows rotation to extend pipe life. Light weight of flexible pipe (11 lb per ft for 6-in. ID) increases support spacing to 8 to 10 ft apart, and supports may be lighter, less cumbersome.

Couplings for flexible pipe include integral-molded flanges and various special ring flanges. Ring flange in Fig 3 couples easily to standard flanges or matching ring flange. Pipe rotation doesn't require flange bolt removal—just slack off, turn pipe and tighten again. This feature allows you to align flange holes without wrestling pipe sections around to fit.

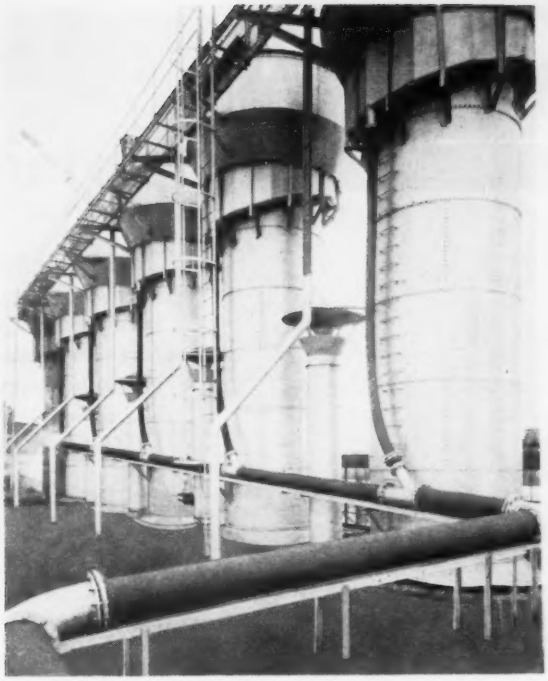
Field-assembled joint for rubber-lined steel pipe is now possible with special spacer device. Manufacturer supplies components of field-assembled joint which can be used for new pipe installations or for changes or additions to existing rubber-lined systems. Joint design permits quick, economical alterations in existing rubber-lined pipe installations to add more outlets, install new equipment or relocate old equipment. Field-joint spacer cuts cost by allowing quantity users of rubber-lined pipe to order 20-ft random lengths from stock.

Regular maintenance men, mechanics or pipe fitters can easily install joint by following simple assembly instructions. Resultant assembly is liquid and gastight. Joint uses standard companion flanges readily obtainable locally. Flanges screw onto pipe sections, using conventional equipment and methods.

Switch from heavy cast-iron pipe to rubber-lined steel doubled pipe life,



3 Flexible pipe solves problem of getting around corners with ash lines. Ring flange allows pipe turning without removing bolts



4 Hydraulic flyash conveyor system of flexible-rubber pipe must withstand 200 F; also highly corrosive and abrasive service

costs in ash handling

saved about 20 days a year in patching and turning pipe at New Haven Railroad's Cos Cob power plant. The 300-ft pipe carries to a settling basin all cinders and flyash from mechanical and electrostatic collectors. Highly abrasive water-borne ash quickly scoured holes in cast-iron pipe. To forestall trouble, pipe was rotated ⅛ turn every three months. Only a few sections could be turned at a time, requiring five days to complete the job.

Steel pipe now installed is lined with ¼-in. thick rubber compound especially developed for ash-handling systems. Power plant records show pipe served for nearly three years before turning. Even then, light weight permitted turning 200 ft at one time, completing the job in one day. At that time the pipe was turned 180 degrees, giving a calculated total life between two and three times that of cast-iron pipe.

Cost figures for rubber-lined pipe run two to three times as much as heavy cast-iron pipe. But installed costs may be about equal. Maintenance costs tip the scales in favor of rubber-lined pipe, with in-service life running two to ten times the figure for heavy cast-iron pipe. Amount of savings depends on size, complexity of ash system.

Rubber-lined pipe manufacturers

American Hard Rubber Company, Div Amerace Corp. New York, N. Y.

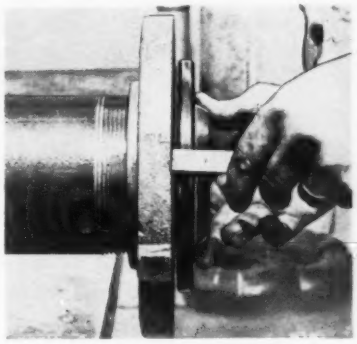
B F Goodrich Rubber Company Dept 0715, Akron, Ohio

Goodyear Tire and Rubber Company Akron, Ohio

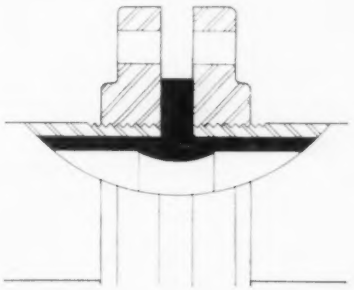
Manhattan Rubber Division, Raybestos-Manhattan Inc. Passaic, N. J.

United States Rubber Company, Mechanical Goods Div, New York, N. Y.

NOTE: Several other manufacturers will line fittings as a custom job



5 Special field joint permits changes in existing lines without special tooling



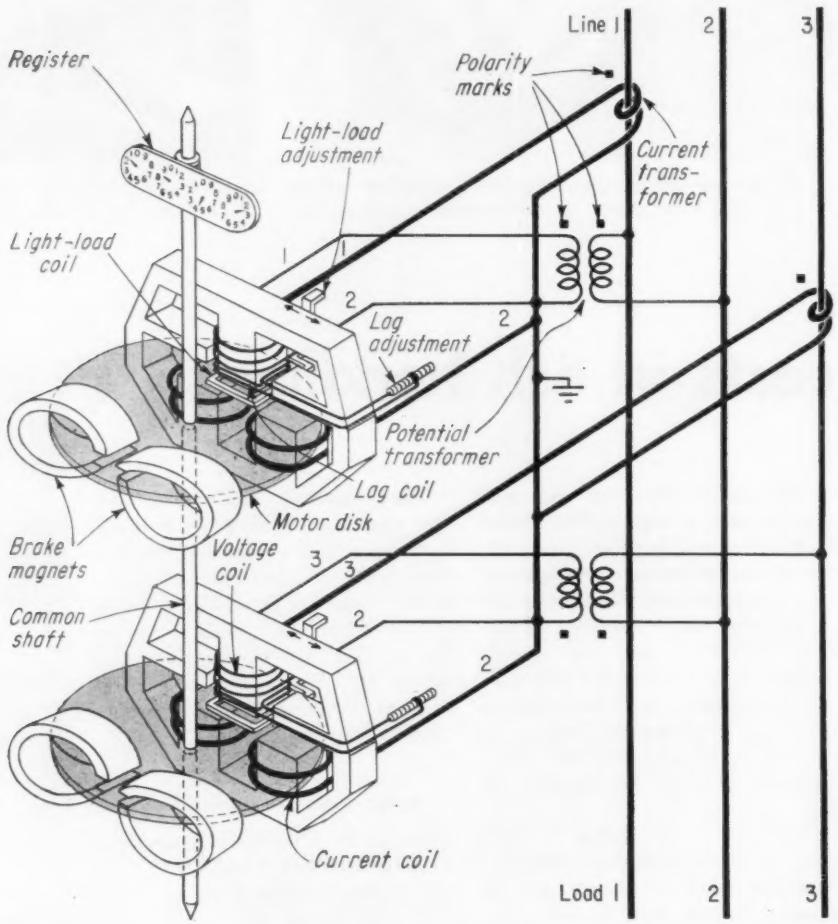
6 Rubber spacer seals field joint between standard steel flanges screwed on pipe

Plant Electrical Fact File

NO. 30: WATTHOUR METERS

Two basic types of

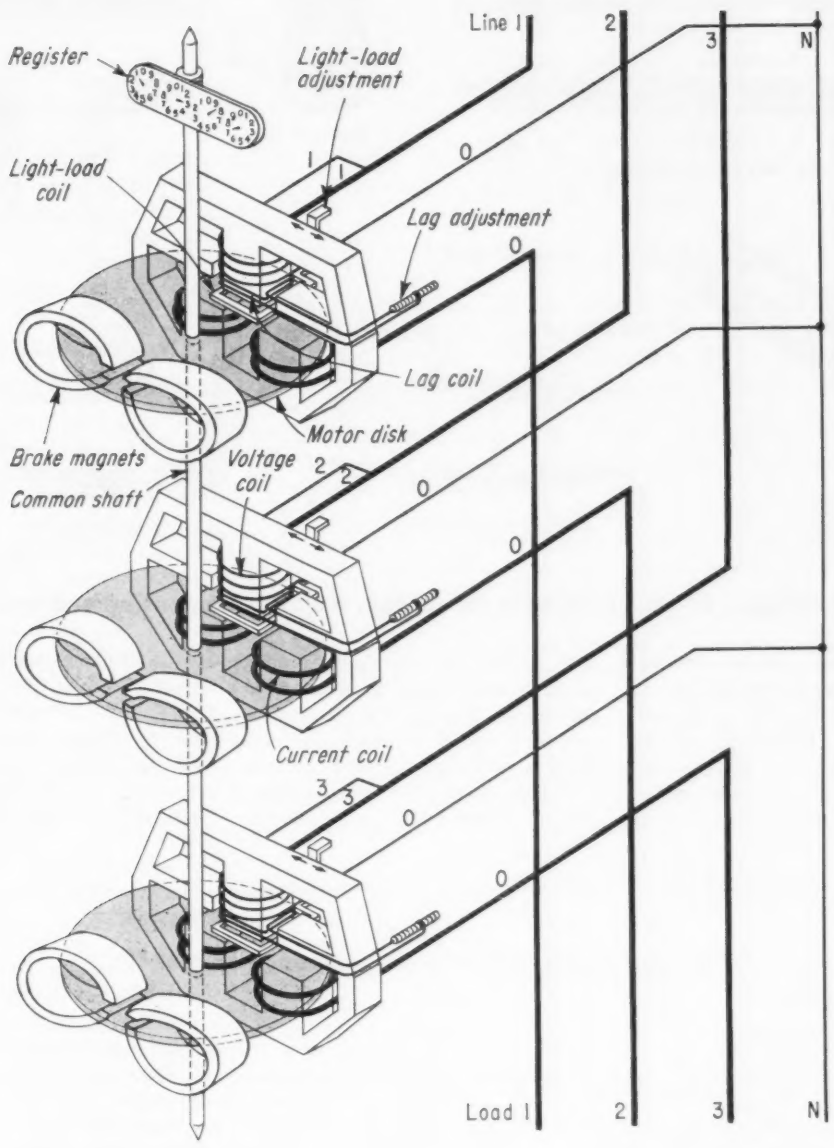
Energy in a 3-phase system is nearly always measured by an induction-type meter resembling the two shown below. The basic meters can be connected into the circuit in a variety of ways, depending on particular conditions. (Watthour-meter connections will be taken up in an upcoming *Fact File.*) Induction meters work on the same principle as induction motors. In the meter's case the rotor is an aluminum disk, suspended by a shaft turning in very-low-friction bearings. Torque is proportional to magnetic fluxes which induce eddy currents in rotor. Fluxes are proportional to current and voltage.



TWO-ELEMENT METER is accurate for a 3-wire circuit. The elements are identical single-phase meters; their combined torques drive the shaft. One revolution of disk represents a certain amount of energy, or watthours. The register totalizes the watthours. Fluxes of the current and voltage coils must be exactly 90 deg out of phase to have the torque truly represent energy. Lag adjustment resistor and coil have a phase-shifting effect to assure accuracy. Light-load adjustment is a shading coil that compensates for friction losses. Brake magnets induce eddy currents in their sector of the disk. Their position is adjustable to set speed of turning disk.

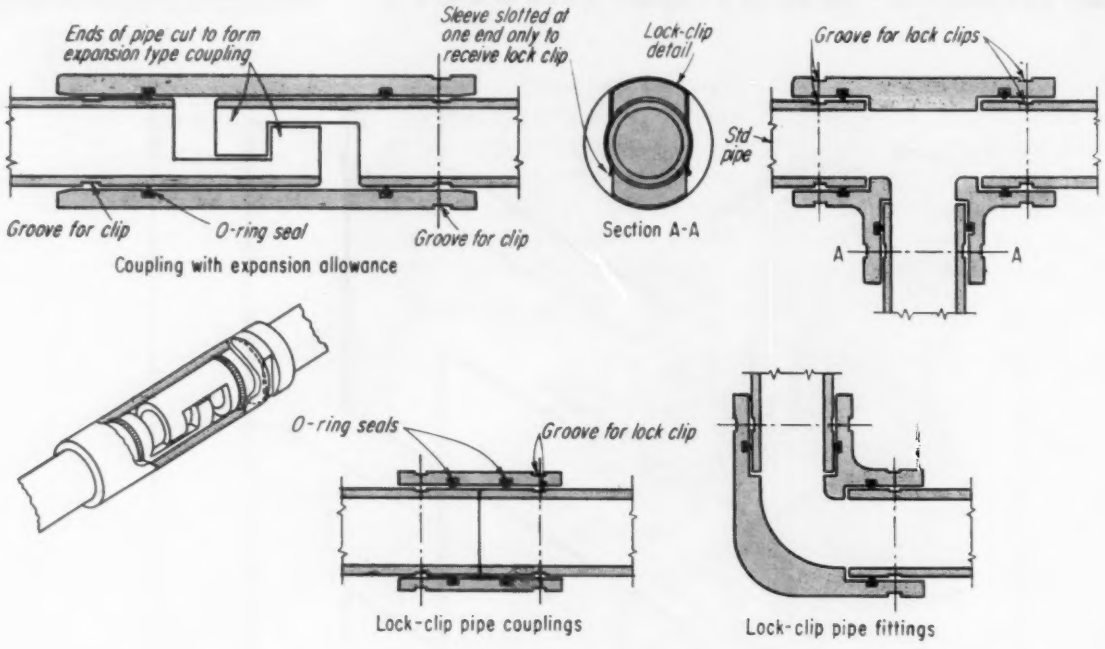
3-phase watthour meters

By NORMAN PEACH, Assistant Editor



THREE-ELEMENT METER is required for 4-wire systems. Elements are the same single-phase meters with a common shaft. Both 2- and 3-element meters require temperature compensation (not shown). It's usually built into brake magnets in form of a bridge that shunts flux in proportion to temperature effects. Line connections shown aren't necessarily used with each type. Current and potential transformers are used with high voltage, large power circuits. Single-disk meters are made; coils act in different sectors of disk. Disks are slotted to separate eddy currents. Single brake magnet does the trick. Still another variation splits current in two current coils

Timely **practical ideas** to help solve

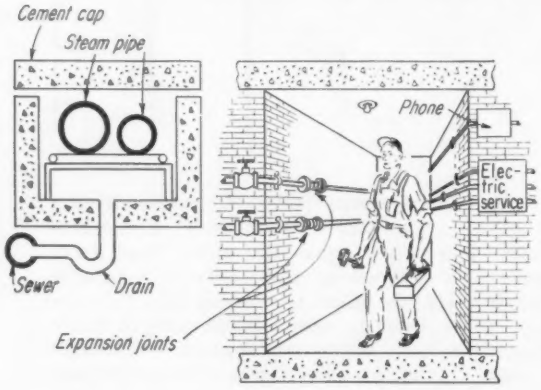


These pipe fittings eliminate threading, welding, cementing and tools

Pipe fittings, shown above, have patents pending, are a new concept. Inventors claim they do away with costly welding, threading, etc and correct the problems of materials like plastic, aluminum and other metals.

Expansion joint, above, used for both plastic and aluminum piping, doesn't need threading, welding or cementing. It permits the maximum and minimum of expansion and contraction as the requirements demand and makes it possible to replace any section of pipe within minutes without use of tools. One feature claimed is that it permits 100% salvage, even in plastics and aluminum, which heretofore had a great tendency to weld themselves. —*Courtesy, American Flow Control Corp, 2220 South Boulevard, Houston, Texas*

For your underground piping—trench or tunnel?



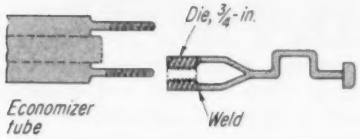
First sketch shows an economical way to pass steam and return lines underground. Here, a trench is used, cement forming sides and top. Add drains or the trench will flood.

Second sketch shows a tunnel used for the same purpose. This is more costly for piping and electric conduits, but it's ideal for maintenance work. If possible, always put piping and conduits on the side of walls. When placed overhead or underfoot, maintenance work is usually slowed.

L HARROP, *New Toronto, Ont.*

your tricky design and maintenance problems

STEVE ELONKA, Associate Editor



Handy thread cleaner

Removing 288 economizer tubes from our boilers in the summer was a real headache. To remove rust and dirt accumulation from the studs, we welded a ¾-in. die to a crank handle.

J M CURRAN, *Desbiens, Que.*

Let's get off our bottoms

Years ago, two identical air compressors were installed in a new compressorhouse beside the powerhouse of a shipyard. One compressor had constant trouble with cylinder lubrication; the other ran perfectly.

Since the chief engineer believed in doing everything from his desk, he sent the manufacturer, who was several thousand miles away, layout drawings and other information asking him what was wrong. He pointed out that the exhaust of a diesel generator ran along the powerhouse roof, opposite the air-compressor intakes about 5 ft away. But, since the exhaust went up vertically from that point for 16 ft, both he and the manufacturer agreed, by correspondence, that this was not the trouble spot. In fact, all the data mailed to the maker was of little help.

After more letter writing, the manufacturer finally sent a trouble shooter to the plant. One look at the exhaust stack up on the roof and the problem was solved. There was no 16-ft vertical section there—as indicated on the drawing. The chief was mighty embarrassed to learn that it had been removed several years ago because it had corroded. So now the exhaust was blowing directly into the intake of the faulty compressor.

Had the chief checked his drawing and then gotten off his bottom to spend a few minutes on the roof, he'd have found the trouble immediately.

P D HOBSON, *Concord, Calif.*

What would you have done?

The stillness of the early morning of April 1, 1942 was broken by the crash of a torpedo striking one of the freighters we were escorting. This was a British Corvette at the tip of South Africa, Cape Abbas, where the Indian Ocean meets the Atlantic. Minutes later we were on full speed, dropping depth charges over a contact. Then we started picking up 33 survivors from the stricken freighter.

Just then I was called to the stoke hold. There was no water in the gage glass and water was pouring out of the tubes into the combustion chamber of one of our Scotch boilers. At the same time, the captain called me through the voice tube and asked for full speed to make another depth-charge attack.

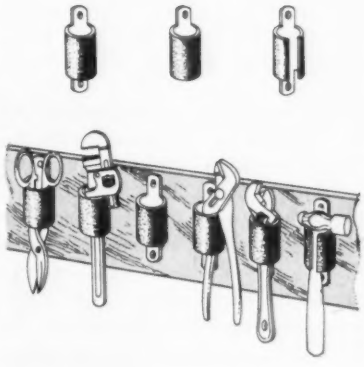
I had a moment of fearful indecision: Should we go full speed and use up what little water we had in the boiler? (Boiler explosion of the *HMS Candsturft* flashed in my mind). Or, should we stay put and run risk of being torpedoed?

"We might as well take the enemy to hell with us," I decided. I yelled to the stoker petty officer, "Feed her salt water." "Full speed it is, Sir," I called into the voice tube to the waiting captain.

Well, we made a successful attack (confirmed). Several moments later I saw a bubble of water at the bottom gage-glass nut.

When we got into Port Simonstown, South Africa, our combustion chamber was like a salt mine. We had to renew 16 tubes. Under the same circumstances, what would *you* have done?

G G HARDING, *Montreal, Can.*



Garden hose makes an excellent tool holder

Cut up leaky sections of old garden hose as shown. It makes an excellent tool holder for your tool board. Use in pairs for some tools, such as heavy tongs. Use split pieces for hammer handle, hand axe or hatchet.

C H WILLEY, *Penacook, N. H.*

Turn page for more Practical Ideas ►

Portable tools pay off, give more accuracy

The improvement in portable tools has been phenomenal. Jobs that at one time required rough makeshift tooling can now be done with great accuracy in the field.

When reassemblying an old 45,000-hp hydroelectric unit following an overhaul, we noticed that the 4½-in. coupling bolts between the generator and turbine shafts did not draw up squarely under the bolt heads. Measurements showed that the holes were oval and out of line by some 3/16 in. There also was evidence that the coupling faces had been rocking slightly.

This unit had been an offender for years. We had to change the guide-bearing often due to the shaft's swing. So we'd rebore the coupling holes and make up a new set of bolts. Bolts showed evidences of stress. By reboring, we'd eliminate possibility of poor fit causing the shaft to swing.

When the machine was installed 30 years ago, the generator people made the shaft for the generator, the turbine makers made the shaft for the turbine, and the job of fitting the coupling was left to the field erector. Tapered bolts were used at that time, so the erectors used a large tapered reamer to match the holes in each half of the coupling.

Old-timers explain that the reamer was mounted on the old-man or bracket, with a huge ratchet on the reamer's end. Then, with a length of pipe slipped over the ratchet handle, two husky men supplied the driving power—not too accurate a method.

To rebore the coupling holes on our job, we rented a Van Norman boring bar, complete with operator. This machine has a variety of uses, but reboring large coupling holes may have been a new application. Accuracy was of a high order, being within 0.002 in. It took two days to rebore the twelve holes.

While I didn't claim that the ill-fitting bolts were entirely the cause of the shaft swing, the unit has been running several months with a swing of under 0.005 in.—a very fair figure for units in the 40,000-hp range.

L McWILLIAMS, *Shawinigan, Que.*

Have you heard . . .

of the world famous Murphy's Law?

- If it can fail, it will.
- If it can be hooked up wrong, someone will do it that way.
- If it can be operated incorrectly, someone will run it that way.
- *All* failures occur at the worst possible time and place. *(Post this)*

Watch the lowest bidder

High condensing pressures were a problem in a 15-ton Freon-12 refrigerating plant. The high-pressure cutout often operated and stopped each of the three compressors. Machines were on a steel frame, with shell and tube condenser below.

I found trouble inside the condensers: Tubes were nearly clogged with algae from cooling-tower water.

Condensers are usually clean—but not these. There was just a 12-in. clearance between the ends of the condensers and a partition separating the machinery room from a refrigerated room. Opposite ends of the condensers had only 18 in. of space to the outside wall which ran parallel to the street. There was no room to scrape the tubes of any of the condensers, nor was there room to replace faulty tubes.

You guessed it. Job of furnishing and installing this plant went to the low bidder as usual. And he's the guy who gave the owner space requirements for the compressor room. To ball things up even more, there were no liquid receivers, high- or low-pressure gages, no bypass around the liquid-Freon dryers, and no strainers on outlet of either dryer.

To solve the problem, we removed heads of each condenser and cleaned tubes with a jet of water from a fire hose. Of course this messed up the machinery-room floor. After cleaning the cooling-tower basin and all condensing-water piping, the plant was put back in service.

Now, to hold down or prevent algae growth in the cooling tower, the water is treated with chemicals.

When will management learn that machinery is installed for keeps; that lowest bidder is often out for a quick buck and does poor work?

C T BAKER, *Atlanta, Ga.*

My biggest boner

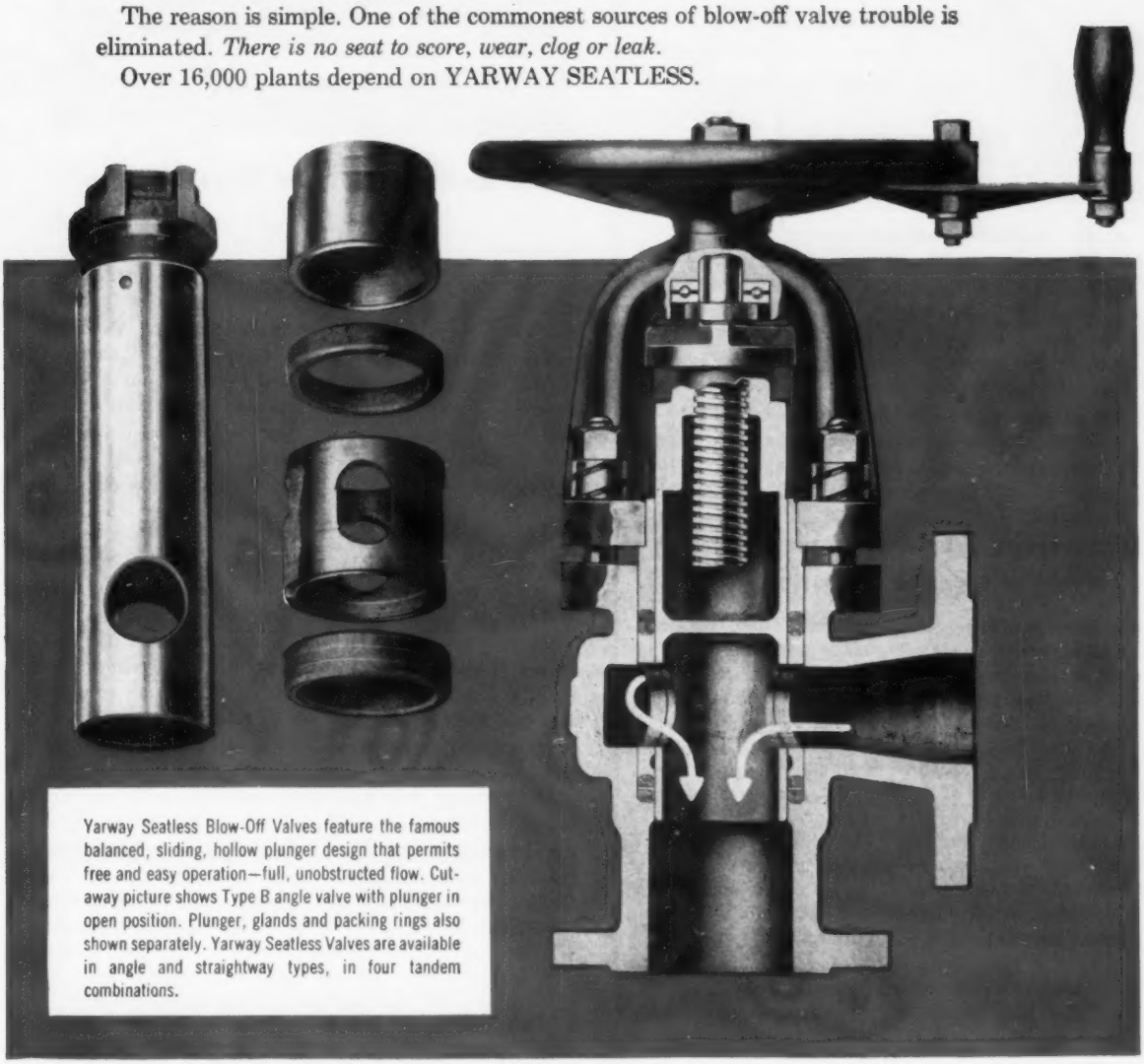
Please turn to page 170

seatless means savings

For nearly 50 years boiler plants in low and medium pressure ranges have been saving maintenance time and down-time thanks to dependable, trouble-free blow-down service from Yarway Seatless Blow-Off Valves.

The reason is simple. One of the commonest sources of blow-off valve trouble is eliminated. *There is no seat to score, wear, clog or leak.*

Over 16,000 plants depend on YARWAY SEATLESS.



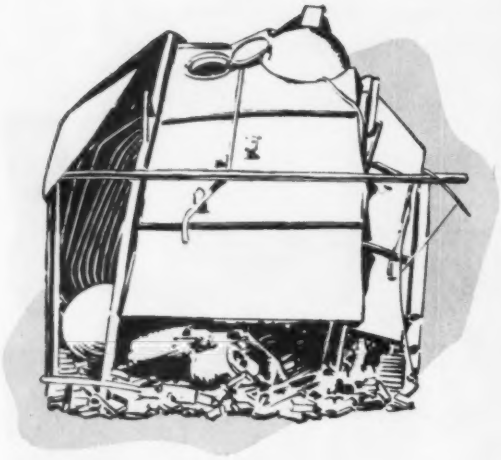
Yarway Seatless Blow-Off Valves feature the famous balanced, sliding, hollow plunger design that permits free and easy operation—full, unobstructed flow. Cut-away picture shows Type B angle valve with plunger in open position. Plunger, glands and packing rings also shown separately. Yarway Seatless Valves are available in angle and straightway types, in four tandem combinations.

For information on Yarway Seatless Valves, sizes, materials, pressures, etc., write

YARNALL-WARING COMPANY 100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY SEATLESS ...a good way to specify blow-off valves.

These **plant problems** could well be yours...



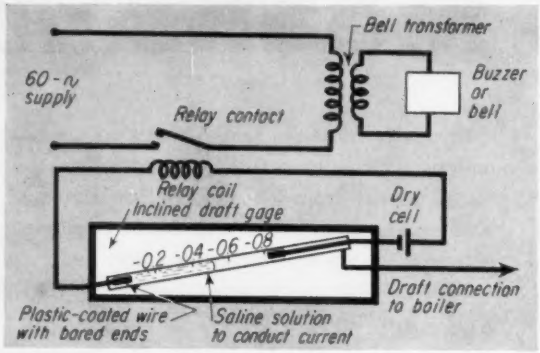
The problem

What steps should we take to avert a furnace explosion?

Our plant has three 30,000-lb-per-hr oil-fired boilers supplying steam for heating and process. Recently there were several disastrous furnace explosions in our area. Since my operators aren't skilled, I'm afraid we may be headed for trouble, too.

Our immediate plans include conversion to gas, so this seems like a good time to do everything possible to prevent this kind of accident. But, how much safety equipment is needed for a foolproof installation? Is automatic ignition necessary? The controls can't be too complex or our operators won't be able to maintain them. This is a new problem for me and it would be of considerable help to know how other readers would meet the situation.—*MH, July* POWER

The solutions



This method calls for alert operators

We use a mercury switch, tripped by a pointer on the furnace draft gage, to detect any sudden loss of boiler ignition. This, in turn, operates a relay that rings a loud bell, warning the operator he's in trouble. There isn't any automatic tie-in to the combustion controls. When the alarm sounds, the operator makes a quick visual check of the fire through a mirror mounted beside the fuel control switches. If no fire is visible, he immediately shuts off the fuel supply. Entire operation from loss of ignition to fuel shutoff takes about four seconds.

Our boilers operate on a balanced draft of –0.03 to –0.06 inches of water. This is automatically controlled by vanes on the forced-draft fans. Mercury switch on the furnace draft gage, above, will trip at a reading of –0.08 inches of water. With sudden loss of ignition, the heat blanket also collapses suddenly, rapidly increasing furnace draft in a negative direction. The alarm value of –0.08 inches of water is reached in less than one second after ignition loss. Since furnace draft control cannot compensate that quickly, this tiny lag in control action actually permits enough increase in draft to serve as a satisfactory indication of ignition loss.

Unit, above, was purchased complete with mercury switch. But *MH* can experiment with a homemade rig to see if system will work as well for him as it has for us. Hook up alarm; trip fuel feed to one boiler; see how furnace draft and alarm work after a sudden ignition loss.

J L WISE, *Reading, Pa.*

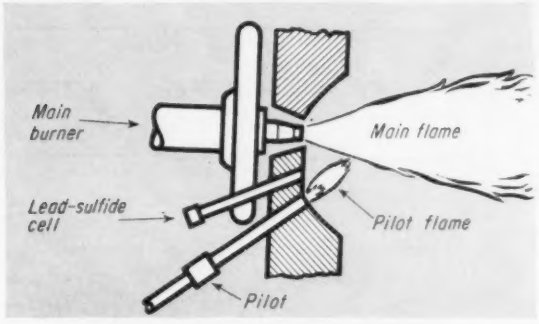
There's no substitute for a trained man

Both oil and gas can be fired with little danger of explosion if it's done properly by an operator who knows what he's doing. Thorough training still ranks high in accident prevention. The man who understands combustion fundamentals will be less likely to cause an explosion and will run the plant more efficiently.

H D FRYE, *Toledo, Ohio*

...Here's how Power readers would tackle them

ROBERT MARKS, Assistant Editor



Use an electronic flame safety system

MH should install an electronic flame safety system to: (1) prevent lightoff when there is a combustible mixture in the furnace by providing programed prepurge and post-purge periods (2) energize pilot light and prove it safe for main flame ignition (3) energize main flame and supervise its existence (4) interlock with other basic safety elements for safety shutoff on low water level, high pressure, draft failure, flame failure, power failure and low fuel pressure and (5) interlock with combustion controls to insure that main flame cannot be ignited except with fuel governor at low-fire position.

Although it will depend on burner design, the best selection is probably lead sulfide cell equipment. This is sensitive to infrared energy of a pulsating nature and can be used for oil or gas. My preference is automatic pilot ignition for forced-draft units and torch ignition for atmospheric burners that are readily accessible.

This system probably isn't as simple as *MH* is looking for. But each component is a standard, readily available item. Complete set of spare parts can be housed in a small cabinet in the boiler room.

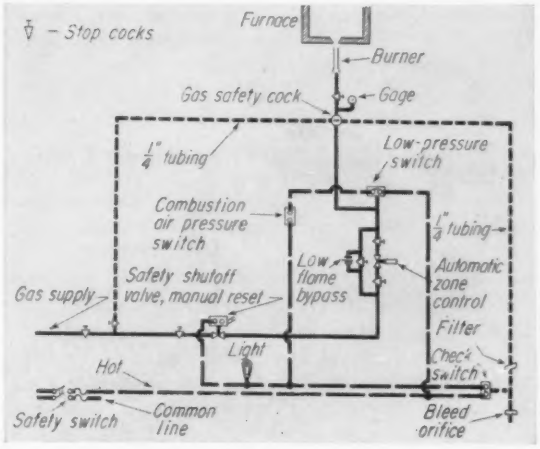
W H KEITH, *Albany, Ga.*

MH should start training his operators

The human element is very important in any plant. Yet *MH* glibly talks about his unskilled labor. In my honest opinion this term is a misnomer. What it really means is unskilled management. This view may sound radical, but the fact that management can do much to decrease the accident rate in boiler plants needs to be emphasized. No matter whether you use coal, oil or gas, proper selection and training of operators will avert furnace explosions and other equally dangerous plant accidents.

W R PENDER, *St. Petersburg, Fla.*

EDITOR'S NOTE: *Reader Pender recently celebrated his 70th birthday. He writes that he has been a* POWER *reader for about the past 50 years.*



Look into this gas safety valve system

Safe, economical gas-burning operation under the conditions described by *MH* demand automatic combustion control, approved gas safety equipment and thorough operator training. Control equipment maintenance doesn't have to be a serious problem because skilled service organizations are available to take most periodic control maintenance from the hands of the equipment operators. Fortunately, the economies of automatic combustion control are usually enough to pay these extra expenses.

Boilers in the 30,000-lb-per-hr range are large enough to justify automatic combustion control which is compatible with the safety interlock system and reduces the amount of labor for operator supervision to a minimum.

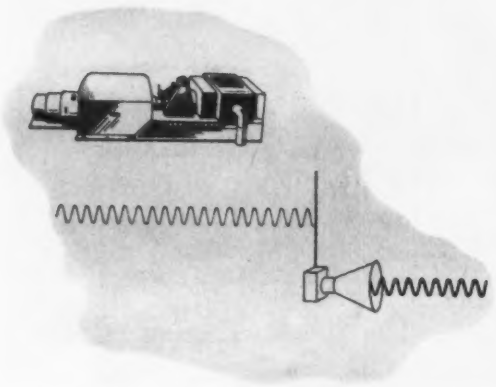
Since the operators aren't skilled, and the new design will reduce the work load, why not pick out the best operators and train them in the correct habits for gas firing? About 50% of all gas-firing accidents occur during lightoff. So in the final analysis, no matter how many safety devices are available, safety depends on the operator following correct lightoff procedure.

MH's gas-conversion plans should be prepared by a consulting engineer. He will coordinate plant needs with equipment design and work closely with the engineering division of the insurance company holding the protection policy on the equipment.

You can also get much valuable information on gas-firing safety controls from the Associated Factory Mutual Insurance Companies. Some of this is shown in sketch above. A permanent low-flame bypass is used around each bypass cock in combination with a low-pressure gas switch. As an alternate you can use a low-gas-pressure switch downstream of each control valve zone.

E F WEHLAGE, *Fairport, N. Y.*

Turn page for new problems ►



The problem

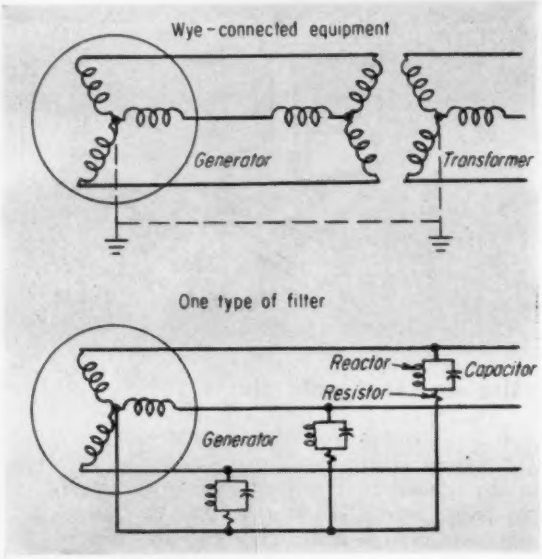
Can we eliminate the 3180-cycle note produced by our generator?

Our plant recently installed a new 700-kw 1800-rpm turbogenerator that is Y connected with the neutral ungrounded. But it produces a 53rd harmonic (3180-cycle note) that interferes with our PA systems, tape recorders, FM radios, etc. By test this harmonic is about 6% of the 60-cycle distortion. The generator has a TIF (telephone interference number) of 40 compared to the standard of 150. So the manufacturer believes the trouble is in our distribution system.

He claims the generator would not produce this harmonic in another network. But it's strange that we don't have the same trouble with our 250-kw 360-rpm generator or our power company tie line. What is causing our difficulty? Can we build a filter that will take very little power and still remove most of this harmonic?—*WCR, July* POWER

Want some help on plant problems? Send us any of your design and operating headaches. We'll put *Power* readers to work on them

The solutions



System changes are probably best bet

While the filter naturally appeals as a solution to *WCR*'s annoying 53rd harmonic problem, it takes a first-hand study by a consulting engineer (preferably of the Marmaduke Surfaceblow variety) to decide whether or not it is practical. Filters involve reactors and capacitors in proper combinations tuned to pass, and hence "drain off" the troublesome harmonic before it can get out on the distribution feeders. One such scheme is suggested above as a possible filter.

Power lost would depend on magnitude of 3180-cycle current. Filters in series with the line to block the harmonic would have to be big enough to carry line current, and would have too much power loss. Reactors and capacitors in any kind of filter are expensive when applied to a power circuit.

It looks to me, though, as if *WCR's* trouble started by installing an ungrounded wye-connected generator in a distribution system that called for a delta-connected generator. When hooked up to wye-connected transformers this may have produced a wye-to-wye system with isolated neutrals. This connection is the happy hunting ground of many unfamiliar harmonics as well as the pesky 3rd, although the 3rd is usually the most important. With a neutral connection on the wye-wye connected equipment, these harmonics can circulate without causing distortion of the voltage wave form. Without interconnection of the neutrals, wave-form distortion is reflected out into the lines.

Before *WCR* resigns himself to living with his unwanted 3180-cycle note he should get the generator manufacturer to make specific suggestions as to how the system should be modified to match the generator. Did

the manufacturer originally recommend a wye-connected generator for ungrounded duty?

Any solution involving changes in the system is likely to be expensive. Perhaps converting to a grounded system is the best way out, since it has other generally recognized advantages which may apply in *WCR's* plant. Reconnecting transformers, if practical, may provide another solution. A delta-connected primary on the transformer shown in sketch would probably take care of all troublesome harmonics as it does the 3rd. A delta-connected secondary would probably be effective, too.

DON KELLAND, *New York, N. Y.*

Power filters are usually expensive

WCR's problem is quite a big order considering the information supplied, but from the description it's very likley that the disturbing harmonics emanate from the new wye-connected generating unit *in conjunction* with the distribution system. The latter perhaps uses mixed or two-winding transformer connections, or both. If the load includes ac-dc rectifiers, this is a good place to look for trouble since they can cause harmonics of different frequencies and magnitudes and phase relations. With rectifiers, ac input harmonics can be filtered with a combination of reactors and capacitors; dc output can be filtered. For 3-phase filtering, however, this is generally complicated and very expensive, and (if rectifiers are involved) phase shifting is simpler, more effective and advantageous.

Check system further for wye-wye connected equipment. Adding a delta-connected tertiary winding to transformers provides a "pad" to smooth out undesirable harmonics. Last but not least, is it possible to reconnect the new alternator (externally) to delta?

CARL BACHMANN, *Jamaica, N. Y.*

Don't overlook coincidental causes

Sometimes when you install new equipment in the plant, problems start attracting attention that look as though the new equipment is directly to blame. But when you track down the trouble, the new equipment is only indirectly to blame, or maybe not the cause at all. *WCR's* solution may be relatively simple when the cause is pinpointed. Look into these possibilities:

Have you checked system for high-resistance ground?

How many autotransformers do you have in your distribution system?

Do you have isolated phases which might cause eddy currents going to ground?

Did you make any other changes when you installed your new 1800-rpm generator?

CLYDE G HOWARTER, *Canton, Ill.*

Correction

In August *Plant Problems*, p 133 under "Cost of acid cleaning is moderate," the fourth item of cost should read "one industrial pump truck for six hours . . . $118," instead of for 24 hours.

Your November problems

How do you keep swallows away from electrical substation buses?

In our electrical substation we have a little problem with migratory swallows, which up to now, we haven't been able to solve. At night swarms of swallows roost on both high and low voltage buses, depositing large quantities of excrement that eventually develop into flashover. We've tried to discourage them by spraying oil and steam into the air adjacent to the substation. But oil is too messy and steam doesn't have any effect. An air blower was also tried in another unsuccessful attempt to discourage their roosting habits. How can we solve this problem? Undoubtedly many POWER readers have faced the same situation.—*JJO*

What's the best way to install bypass on our steam valves?

We plan to install bypasses on a series of main steam valves. Valve body material is gray cast iron of good uniform structure. The line operates at 125 psi. It's our present hope to cut costs by using the original valves and either drilling and tapping or drilling and welding in the nipples needed for conversion.

Before going ahead, I'd like to know if brazing or welding can produce enough heat to warp the valve body? For the weldments involved, is the arc method faster than the gas method? How do all these methods compare in cost? What do POWER readers consider the best way to install this valve bypass.—*TA*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

Your page for **comment**

BOB BELLAS, Associate Editor

Where credit is due

Your article describing the Second Annual Mutual Aid Conference in Elizabeth, N. J. ("Include your neighbors in your disaster plans", August 1958, p 116) was most interesting. However, it conveyed the erroneous impression that the Linden (N.J.) Industrial Mutual Aid Council sponsored the conference. To set the record straight, LIMAC was *host* for the affair which was organized and sponsored by the Industrial Security Institute.

This is the second such conference to be held under our sponsorship. The first was held in Charleston, W. Va. last year with the Kanawha Valley Industrial Emergency Planning Council as host. Another industrial mutual aid group will serve similarly next year.

For the past five years we've been fostering the mutual aid group movement as the one strong means for effective preparedness in industrial communities. The program will provide an industrial and civil defense setup which can be counted on to function in either peacetime or war emergency.

ISI activities cover the full range of industrial preparedness for disaster. Forums, seminars and conferences provide access to information not generally available. Reports of various types make additional information readily usable.

S A ANTHONY JR, *Executive Vice-President*
The Industrial Security Institute, N. Y.

It's how you bungle it

I'm surprised at your article on "Easy way to empty oil drums" (*Practical Ideas*, August, p 129). Easy way to commit suicide, I'd say. A fellow was emptying a drum this way on a cold day in Duluth, Minn. Oil was stiff, and safety valve was set at 5 psi. The guy was in a hurry and to increase flow he set the safety valve to pop at higher pressure. Both heads came off the drum; one head severing one of his legs above the knee. Any questions?

L M LARSON, *Milwaukee, Wis.*

. . . Anyone who tries this according to the sketch will give it up and go back to the old way. We empty our drums with compressed air all the time, but we put the air in the *little* bung and let the oil go out the *big* bung. Much faster that way.

D L COCHRANE, *Cambridge, Minn.*

Don't throw that first stone

I note that POWER is scolded because of my use of the expression "settle out" (*Comment*, September, p 126). If POWER and I have sinned, we find ourselves in illustrious company. This phrase is common in both written and spoken word of some top-flight engineers—and this we can substantiate.

W J STEINERT, *Long Island, N. Y.*

Howden didn't

I was quite interested in your article "Choosing draft systems for industrial boilers" (July 1958, p 98). But your reference to the Howden forced-draft system isn't quite correct and I'd like to present a few historical facts which will put this matter into its proper perspective.

In his presidential Address to the Institute of Engineers & Shipbuilders in Scotland on Oct 16, 1923, the late J Howden Hume (at that time chairman of our company) said that the honor of first using a blowing fan on board a steamship belongs to Edwin A Stevens of Bordentown, N. J.

In 1827 Stevens fitted the boilers of the steamer *North America* with closed ashpits into which the air for combustion was forced. About the same time Ericsson similarly fitted the steamer *Victoria*. Stevens persisted in his experiments and it is a matter of record that he tried three different methods of using a fan for promoting combustion: (1) blowing direct into a closed ashpit (2) exhausting the base of the stack by fan suction (3) forcing fan discharge into an airtight boiler room or stokehold. This gave birth to the three systems known as closed-ashpit forced draft, induced draft and closed-stokehold forced draft.

It wasn't until some forty years later that Mr James Howden became interested and, after taking out several patents, evolved the Howden forced-draft system in the early 'eighties. This consisted of a fan blowing through an air heater into a casing attached to the boiler shell. Air from this casing entered the furnace fronts through valves. The stokehold could be ventilated naturally. The fan delivered the air through short ducts from air heater to furnace front. Since no excess air was needed for stokehold ventilation, the fan was only required to handle the air for combustion. Further, complete combustion control was effected at the furnace front.

About the same time (the early 'eighties) John Thornycroft of London began construction of torpedo boats fitted with locomotive type boilers. Airtight boiler rooms in these boats promoted high combustion and evaporation rates.

Early experiments with closed stokeholds weren't entirely successful. However, later modifications improved results and the Navy adopted the system and, to a certain extent, retains it today.

D S MACFARLANE, *Director*
James Howden and Co, Ltd, Glasgow, Scotland

Why a Steam Trap Has to Handle "Air"

Low temperatures and corrosion of equipment are often evidence of inadequate trap air venting capacity

Air, with its load of oxygen and carbon dioxide, has an unwholesome habit of interfering with the efficiency of steam heated units. If steam were always free of these undesirable companions, things would be a lot simpler for men-who-operate-plants. Because it isn't, three unhappy situations frequently occur:

1. ***Operating temperatures are subnormal.*** This is a two-part problem. First, an air-steam mixture has a lower temperature than pure steam at the same pressure—see Table A. Secondly, air can "plate out" on heat transfer surfaces as shown in Figure 1. Under some conditions, such an air film will knock down heat transfer efficiency by as much as 50%.

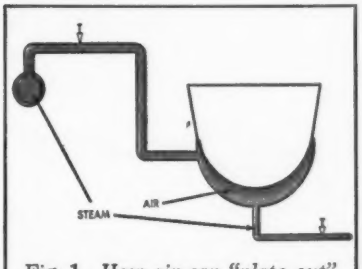


Fig. 1. *How air can "plate out" on heat transfer surfaces. This "insulation" drastically reduces heat transfer efficiency. Armstrong trap operation creates turbulence in the equipment that prevents this.*

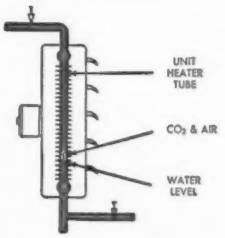


Fig. 2. *Corrosion occurs when units are not kept continuously free of both condensate and air. Armstrong traps discharge both,* at steam temperature, *as fast as they accumulate.*

2. ***Corrosion rears its ugly head.*** Oxygen and carbon dioxide are real trouble-makers. CO_2 gas goes into solution in condensate, forms carbonic acid and chews away at vulnerable metal sections. O_2 aggravates the situation. See Figure 2.

TABLE A—How air reduces steam temperature.

Gauge Pressure	Temp. of Steam with No Air Present	Temp. of Steam Mixed With Various Amounts of Air (% Air by Volume)	
		10%	30%
10.3	240.1	234.3	220.9
25.3	267.3	261.0	246.4
50.3	298.0	291.0	275.1
75.3	320.3	312.9	295.9
100.3	338.1	330.3	312.4

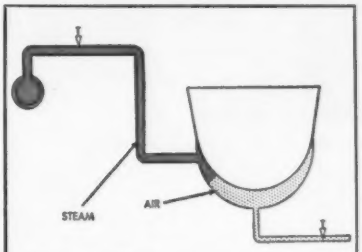


Fig. 3. *When steam is turned on, it takes a trap with extra air venting capacity to provide fast heat-up.*

3. ***Heat-up is slow as a snail.*** Air has a picnic in units that are shut off periodically. Figure 3 pictures the problem. Lines and equipment literally fill up with air. When the steam is turned on it can get in only as fast as the air gets out.

Enter Steam Traps

Curing these steam system ailments involves an operation sometimes called a "trap transplant." It consists of removing traps that don't get the air out and replacing them with traps that do.

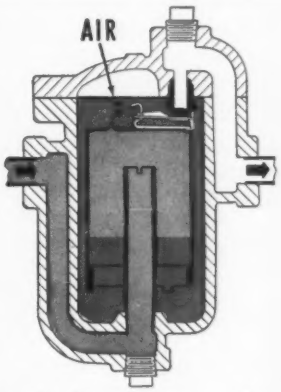
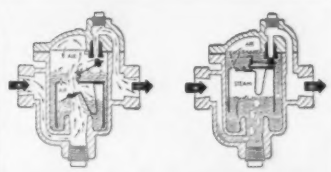


Fig. 4. *Air entering an Armstrong trap passes through the bucket vent and accumulates in the top of trap. When trap opens, air is discharged along with condensate.*

Figure 4 shows how an Armstrong inverted bucket trap continuously vents air. What the picture doesn't show is a built-in plus-value of this trap's design. An Armstrong trap opens suddenly, creating a momentary pressure drop and turbulence in the unit being drained. This breaks up air films and "pumps" air down to the trap so it can be vented.

The vents in standard Armstrong trap buckets will pass all the air normally encountered. In special cases, such as paper machine dryers, the vents are correctly sized larger at the factory to meet the requirement.



Thermostatic vent open. *Thermostatic vent closed.*

Fig. 5. *Open float with thermostatic vent for off-and-on units. When trap is cold, vent is open, permitting air to blow through when steam is turned on. When steam reaches trap, heat closes thermostatic vent. Then, regular bucket vent handles all air coming in with steam.*

Open Float with Thermostatic Vent

Super air-venting capacity is a must for fast heat-up of low pressure unit heaters, heating coils, steam headers and other units that are on-and-off. Figure 5 shows how the Armstrong open-float-with-thermostatic-vent trap takes care of this.

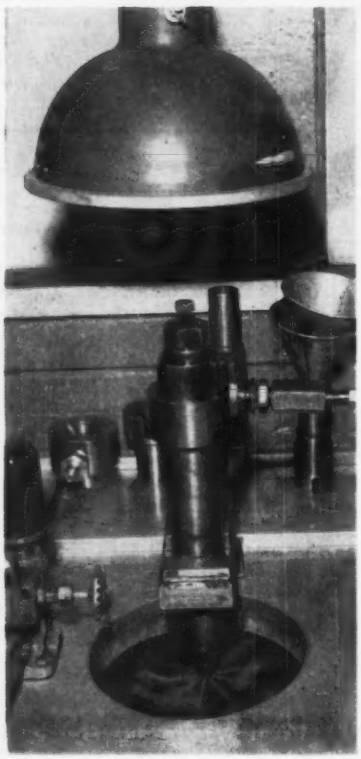
* * *

The 44-page Armstrong steam trap book covers other features of the Armstrong trap as well as its excellent air handling characteristics. This catalog also discusses trap selection, installation and maintenance. Your local Armstrong Representative or Distributor will be glad to give you a copy. Call him, or write Armstrong Machine Works, 8122 Maple Street, Three Rivers, Michigan.

ARMSTRONG STEAM TRAPS

BLACK LIGHT, *above,* and dye penetrant in fuel oil help to show spray pattern effectively

How to black light test fuel nozzles



SPRAY PATTERN is seen easily, quickly

Now, fuel-injector operation for diesel engines is checked with black light by the Southern Pacific Co, El Paso, Texas. Fuel is forced through the nozzle and resulting spray pattern is observed under black light which causes the fuel to fluoresce or glow. Thus, spray patterns are easy to observe in detail.

Efficiency of fuel injection is critical in diesel performance because of danger of oil dilution. Fuel injector must atomize the fuel oil at the proper instant so combustion is complete. If injector is not operating properly, incomplete combustion occurs—fuel goes past the rings and pistons and into the lube oil.

This inspecting method makes use of high intensity black light, instead of normal illumination previously used to observe spray pattern. It's faster, easier, more effective than older method. And, a small amount of fluorescent dye added to the fuel oil makes the test even more sensitive. Black light is the term used to describe invisible radiations in the near-ultraviolet range of wave lengths. A special filter eliminates almost all of the visible light emission. There are no harmful effects to eyes or skin.—*Courtesy, Magnaflux Corp, Chicago, Ill.*

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for HIGH PRESSURE and HIGH TEMPERATURE PIPING

custom made to your mechanical and metallurgical specifications

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TEES

PIPE

VALVE BODIES

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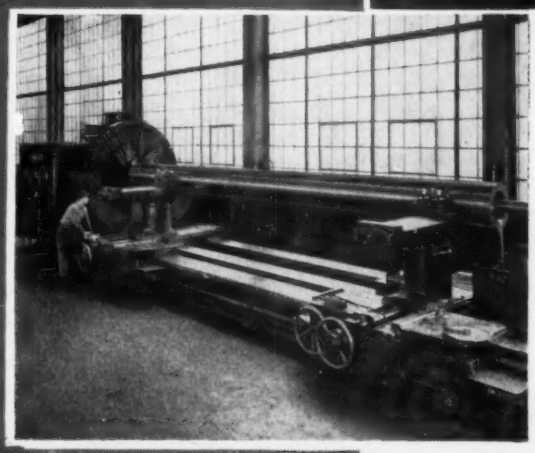

Turning and boring high Pressure — High Temperature Pipe on a MESTA 100" HEAVY DUTY LATHE is one of the Mesta Machine Shops.

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MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

"Bert and a German engineer came aboard as we started loading green coffee in Santos, Brazil," said Marmaduke

Marmy's low resistance

"BILGEWATER on plant design," roared Marmaduke Surfaceblow in his foghorn voice at the Bent Propeller Bar yesterday. "I'll tell you modern engineers about the time I found a current leak in a temperamental Brazilian generator that had the experts stumped . . . and all I did was prove that some up-to-date materials are too modern for today's electrical equipment."

What started that outburst? Well, I thought our Plant Design issue would get a rise out of the old consultant, so I barged into the Bent Propeller Bar and plunked it down before him. Sure enough, it worked.

Marmy was leaning over the crowded bar, ballasting his double bottoms from a bottle of Sandpaper Gin. After shoving POWER before him, I asked, "What's your view on today's plant design, Mr Surfaceblow? Our October issue is devoted to that subject exclusively. I know that POWER readers the world over are anxious to have your highly respected thoughts."

That's when Marmy banged down his bottle and suddenly cried out, "BILGEWATER on plant design."

I quickly ordered a short beer and settled down to listen. The other cash customers stopped their yapping and tuned in to Marmy's wave length.

Here is our hero's story.

"Back in 1947 we pulled into Santos, Brazil aboard the freighter *SS Osprey*, on our way up the coast from Argentina. Soon after we tied up to the busy coffee dock at noon, my old shipmate Bert Warman came up the gangplank. Bert and I did some steamboating years before aboard a Mississippi River stern wheeler.

Bert had a German engineer, Victor Schultz, in tow and we shook hands all around. Bert told me he had been super at a new industrial plant up in São Paulo for about a year. Said he heard I was aboard the *Osprey* and came down to get my help on an electrical problem that was driving them all nuts.

"I was glad to see him and suggested that we go down the dock to the Marina Bar for a steak dinner and some beer. Since that suited them both fine, we soon were ballasting our cargo holds with the best steaks in South America, and washing them down with beer.

"Bert opened up and went into details about his problem. He explained that a new German 40,000-kva generator had been installed at the plant a few months before he took the job. The generator ran OK for a while, then suddenly her bearing temperatures shot up from 60 to about 67 C for no good reason that anyone could dope out. After that the temperature started climbing gradually until it hit 80 C, where it came to roost like

(Continued on page 162)

MESTA MACHINE COMPANY
PITTSBURGH, PENNSYLVANIA

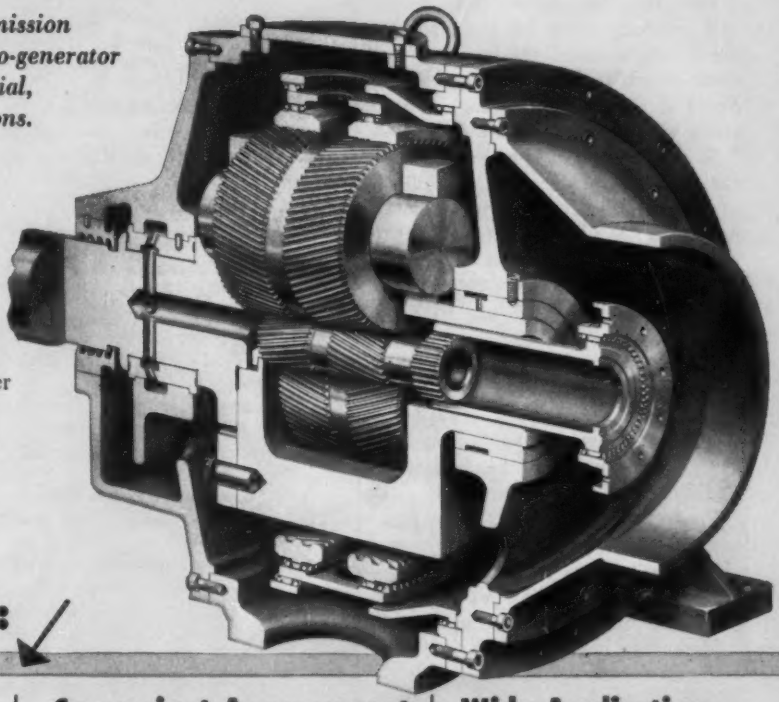
DE LAVAL-STOECKICHT
PLANETARY GEAR

...for high speeds...high horsepower

Proved in hundreds of installations abroad totalling over 3,000,000 horsepower—now available in America!

For all high torque power transmission applications such as pump turbo-generator and compressor drives in industrial, municipal and marine installations.

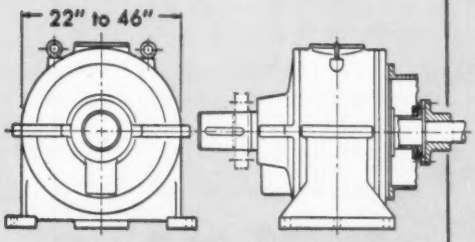
This cutaway view of the De Laval-Stoeckicht Planetary Gear shows how it provides flexibility for proper load distribution throughout the gear members. The thoroughly proved and tested design is completely reliable in transmitting high horsepower for high speed applications. • Highest efficiencies (98% or higher)... no high speed bearings... less friction losses.



Check These Advantages:

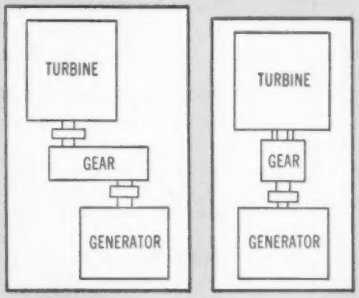
Small Size—Light Weight

Compact—low weight per hp. Sizes range from 22" to 46" in diameter, depending on horsepower requirements. Example: 5000 hp planetary unit weighs 1700 lbs. against 6000 lbs. for conventional gear.



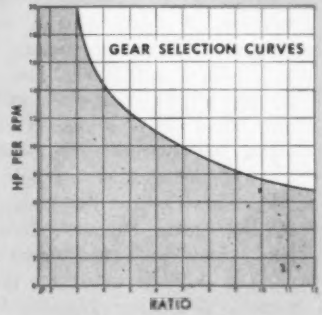
Convenient Arrangement

Co-axial or "in-line" arrangement of gear members takes up far less space than parallel axis gears of equivalent horsepower rating.



Wide Application

Capacity range shown in shaded area on chart below. For other applications, contact your De Laval Sales Engineer.



For further details, write for Bulletin 2400.

DE LAVAL *Steam Turbine Company*

815 Nottingham Way, Trenton 2, New Jersey

BL431

Reports from the field

What's happening in power and what it means to you

Volcanos pour out steam direct from earth to plant

While using high-priced fossil fuels and precious water for their power needs, engineers of the world's volcanic countries have enviously wondered if they can't tap the natural steam seething under their feet.

Mexico, sitting atop enormous volcanic pools, has decided to utilize some of Mother Nature's free steam. According to McGraw-Hill World News our neighbors to the south will soon generate their first 3500 kw of volcanic electricity, with specially designed turbines and generators fed by volcanic steam coming from wells in Pathé, Hidalgo State, 130 kilometers from Mexico City. This will be the first "geothermic" plant in the Western Hemisphere, and should start up by the end of this year.

Production of electricity from volcanic steam is not a completely new idea. Italy has had geothermic plants for 30 years, with total installed capacity running to 257,000 kw.

Method to be used in Mexico will be direct for the pilot plant, probably mixed in the future. In the direct method, steam from the volcano goes right into a reaction turbine, where boric acid and ammoniated steam are extracted. In the mixed method, steam is gathered into a collector, then distributed to condenser-equipped turbines. A third indirect method, favored in Italy, uses natural steam to produce and reheat pure steam through a boiler with a heat-exchange unit. Pure steam is applied to a reaction and condenser turbine.

As Mexico taps her volcanic pools, other countries are also looking into the free-steam bonanza. New Zealand's first geothermal steam power plant is slated to go on the line this month, producing 250,000 kw of power. And in the U.S., Pacific Gas and Electric Company will produce electric power from the natural steam of Californian geysers—first plant expected to generate 12,500 kw.

Power lines

Sea waves will power an experimental plant, produce electric energy for Spain. Waves move a hydraulic elevator which controls floats; floats attach to rods which drive pistons, raise water to run plant's turbines.

Air-conditioned space in Manhattan has passed the 50% mark for major office buildings, according to Hudik-Ross Co president Frank Hudik.

National Electrical Week is scheduled for Feb. 8-14, 1959.

First water desalter plant in the east will remove 200 lb of salt per day from 12,000 gal of brackish water for a N.Y. Thruway restaurant.

Clean air is now a must in Great Britain. For emitting dark smoke, a plant may be fined £100.

Cows enjoying air conditioning and cooled drinking water during the summer grow faster than their uncooled comrades, AIEE has discovered.

Paper sandbag has been invented by U.S. Army engineers. Knitted-paper bag lasts 60 days in severe weather.

Artificial reservoir, world's largest, will be built by USSR on the Angara River. Proposed "Bratsk Sea," they claim, will cover 5500 sq kilometers, have an artificial waterfall twice as high as Niagara Falls.

Guaranteed cyclone tubes for mechanical flyash collectors are announced by the Aerotec Corporation. Tubes must last at least 100 months.

Sulfur content in gas used as fuel and in liquid fuel may soon be limited in Los Angeles. Public hearing has been set on this antismog measure.

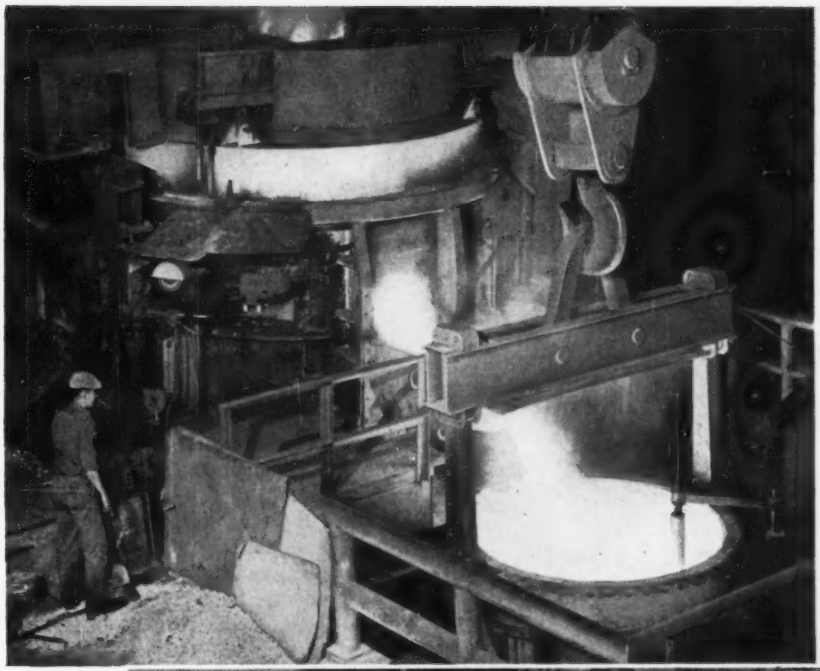
Largest generator, a 519-ton 384,000-kva model, is on order for Arkansas Power & Light Co's $56,000,000 steam plant near Helena, Ark. Westinghouse Electric Corp will build it.

Boiler explosion, according to Bennett Cerf, occurred because "the engineer was full and the boiler was empty."

Niagara Falls is being reproduced, on a 1 to 50 scale, by Worcester Polytechnic Institute. The 600-ft L-shaped model will be used as a check for the real Falls power project.

Share-the-wealth policy has been proposed by Westinghouse Electric Corp—digital computer programs to be exchanged free of charge between manufacturers, utilities, through a clearinghouse such as the EEI.

For Calendar of Events turn to page 206



Tapping a 50-ton arc furnace at B&W Barberton works.

Rigid quality control is maintained through all phases of production down to final inspection.

Why B&W Hollow Forged Piping Gives Long, Dependable Service

At B&W, quality control of Hollow Forgings is constant from initial melt to final inspection of the finished product. This *integrated* control is a big reason why B&W Hollow Forged Piping is the most practical choice for main steam, reheater, feedwater, and other heavy-duty high-pressure or high-temperature lines.

Testing at B&W includes analysis and grain structure examinations—hydrostatic test—and ultrasonic test as standard procedure. What's more, B&W machines the outside surface of every forging, to assure good appearance and ease of fabrication.

B&W Hollow Forged Piping is available in a wide range of sizes, in carbon, alloy and stainless grades, and is made to ASTM specifications. There is a size and grade close to your optimum design requirements. For more about how B&W Hollow Forgings meet your needs best, write for Bulletin S-16. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

S-475-HF

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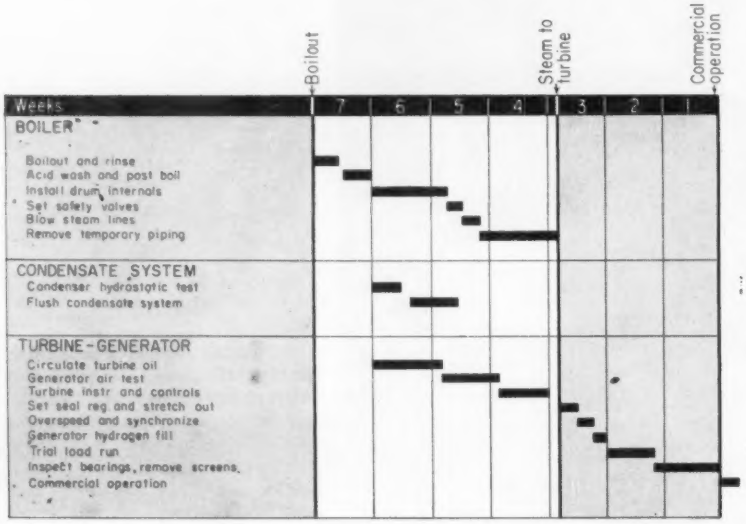
BOILER DIVISION

Technical briefs

Latest engineering developments for busy power men

7 papers for you on:

SOLAR ENERGY
PLANT ECONOMICS
GENERATORS



FROM BOILOUT TO OPERATION takes six, eight or more weeks. Here's where good planning cuts time, saves you dollars. This schedule itemizes a 7-week startup

Careful scheduling can cut time between boilout and operating date

From boiler boilout to operating date. *By J A Donald, N A Miller and C D Blancke, Sargent & Lundy, Engineers*

When a large steam-electric powerplant unit is authorized, one of the basic factors involved is the operating date. This date usually dictates release of the authorization.

Soon after authorization, engineers must prepare a schedule for the design and construction work. This includes a list of the principal items comprising the plant, together with dates for purchase, design, shipment and construction. All dates must be coordinated to make sure final construction will be completed prior to the designated operating date.

The final phases of the work include testing and preliminary operation so that the operating date will be met.

In this paper, the authors attempt to outline the necessary steps in startup procedure, the sequence relations between them, and finally the overall time required.

They conclude that the proper time to begin thinking about scheduling the unit starting procedure is very early in the job, when overall construction schedules are prepared. Startup time should be itemized in these schedules.

Approximately four months prior to scheduled starting date, personnel and plans should be organized and progress evaluated. At this time the practicability of the scheduled operating date should be reviewed, and either confirmed or adjusted to permit the required starting procedure.

A man of ability should be in charge of starting procedure, and he should have the authority to coordinate all the groups involved. During testing and preliminary operation, continuous communication should be maintained between all involved. This should be accomplished by daily conferences of a few people, supplemented by charts and check lists to remind each group what is required for coordination.

Six to eight weeks are required from boilout to commercial operation. Efficient management can reduce this to the minimum figure. Inefficient management can prolong it well beyond the maximum figure. But reducing the starting period, even by two weeks, can produce savings to the owners far in excess of the cost of good planning and organization. *APC paper, no number*

Bay Shore generating station, an analysis of specific electrical features. *By R May and C M Gardam, Toledo Edison Co.*

When, a few years ago, it was seen that the facilities for the company's Acme generating station were extremely limited, it was decided that a new station should be built which would ultimately exceed Acme in generating capacity. Much thought was given to planning a unit that would afford the economy, reliability and flexibility required of a major power source on a comparatively small system. The result was Bay Shore station, a modern steam-generating plant located on the south shore of Maumee Bay, just east of Toledo.

Paper describes the general plant design, generator and excitation system, 138-kv substation, protective relaying, generator leads, auxiliary power system, motor protection, smaller motor controls, lighting system, communications, cable and conduit system, plant battery system and emergency power generation. *AIEE paper, No. 58-512*

Solar energy

A one-watt solar power plant. *By D H Smith, Bell Telephone Laboratories, Inc*

Shortly after the announcement of the invention of the Bell Solar Battery, Bell Telephone Laboratories un-

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*TM for DuPont Tetrafluorethylene resin.

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dertook an exploratory development program with a twofold purpose. First, they wanted to learn how to make large quantities of silicon photodiodes, how to devise reliable connections to the active parts of the diode and, if possible, how to increase the realizable efficiency of conversion of sunlight to electricity. Second, they wanted to find out how to use the new photodiodes in the most efficient and practical way in telephone-equipment power plants.

Reasonable progress has been made. Efficient silicon photodiodes with reliable electrical contacts were fabricated in quantity, and similar diodes are now on the commercial market.

Also, fundamental system- design problems have been explored and solutions to a number of these problems have been obtained.

This paper describes some preliminary work that culminated in the field experiment. Preliminary tests are discussed, and data are summarized. *AIEE paper, No. CP-58-186*

High-altitude performance of silicon solar cells. *By K L Niebauer, Boeing Airplane Co*

Silicon solar cells can be used at extremely high altitudes and in space without experiencing damaging temperatures. The equilibrium temperature in space may vary somewhat from the 135 F figure established by this test program. But there is a considerable safety factor between equilibrium temperature under test conditions and cell's 350-F limitation.

The solar converter has a definite place in the accessory power systems of today, but its importance will increase with advances in space vehicle designs. Using silicon solar cells for satellite vehicles may give the art the necessary impetus; lead to breakthroughs eventually resulting in a solar converter that can efficiently compete with more conventional power generation. *AIEE paper, No. CP-58-914*

Generators

Ground-fault protection of unit-connected generators. *By M N Rajk, Sanderson & Porter Engineers*

The increasing size of turbine generators on large power-supply systems means that the sudden loss of a unit tends to endanger the continuity of power supply over large areas. Because of this, some operating companies prefer to sound an alarm upon the detection of generator ground faults which in themselves do not cause immediate disability of the generator. The unit is then taken out of service in a routine way at the first opportunity.

H R Tomlinson in his fundamental paper on this subject expressed the view that with a ground-fault neutralizer protected unit, connected generator operation may continue for a period after an insulation failure with a minimum danger of further internal damage.

An AIEE committee report, although emphasizing the advantages of a ground-fault neutralizer, presents the opposite view: even a neutralizer-protected generator should be automatically tripped in case of a ground fault.

This paper presents a study on the same topic. The author concludes that grounding the neutral of a unit-connected generator with a ground-fault neutralizer has definite advantages over resistance grounding. *AIEE paper, No. 58-900*

Water cooling of turbine-generator stator winding. *By G V Browning, C H Holley, J F Quinlan, General Electric Co*

This paper presents the results of engineering and laboratory studies on the use of water as a coolant for direct cooling of the copper conductors of turbine-generator stator windings. The report is highly favorable.

The authors conclude that (1) Water as a coolant for large turbine-generators has several advantages: (a) its outstandingly good heat-removal ability will result in even cooler windings than are obtained with oil cooling in present ratings and will make possible much larger ratings in the future. (b) It is nonflammable and universally available. (2) Suspected disadvantages, such as lower resistivity and corrosive-erosive effects, have been shown in laboratory tests to be of no practical significance. (3) Maintenance of water with sufficiently high purity is readily accomplished using the type of deionizing equipment that is well-known in the industry.

(4) Water cooling seems entirely practical and desirable for large turbine-generators. (5) Future possible advantages include the use of condensate as a winding coolant with perhaps some slight improvement in station heat rate. *AIEE paper, No. 58-278*

Power-plant economics

Practical limitations in the determination of the incremental cost of fuel. *By E K Corporon, Interchange Power Services, Inc*

Determining incremental fuel costs on an absolute basis is highly desirable. It is subject to judgment that nullifies in part the high degree of accuracy obtained by the fundamental approach used in determining incremental heat rates for generating units and incremental transmission losses. But this shouldn't stop the application and use of the incremental cost of fuel within the accuracy to which the cost can be determined or estimated.

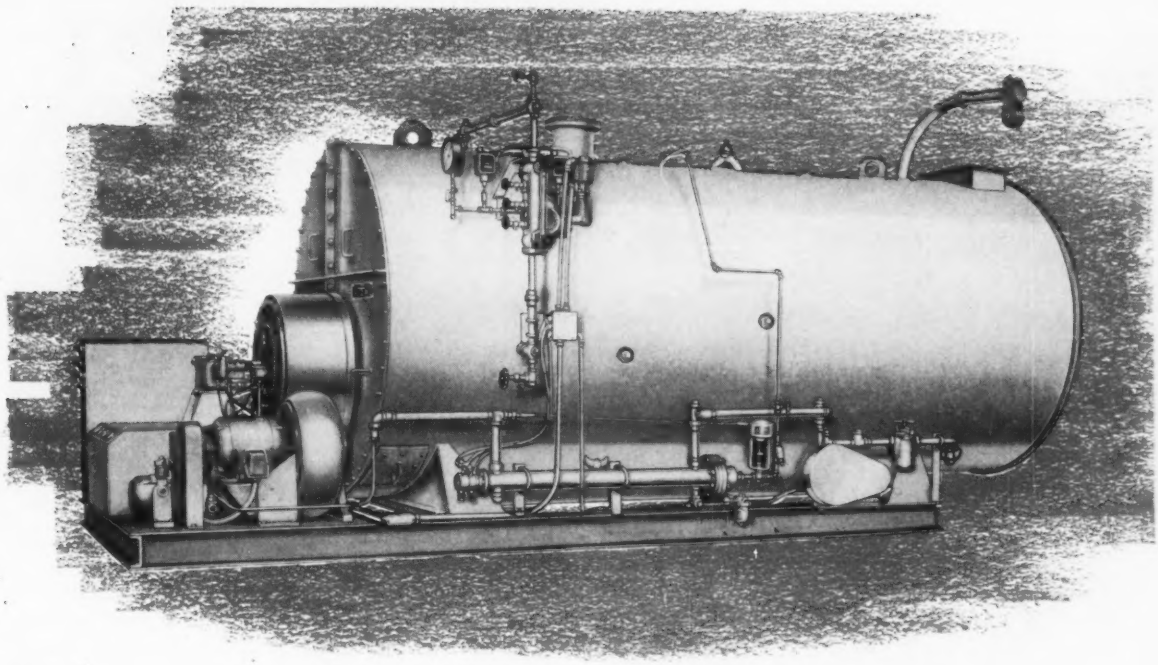
Practical solutions to the problems encountered have been found by using estimated incremental costs of fuel based on a thorough analysis of the operating conditions. The results are more realistic than could be expected from using average costs. Some need for further consideration by those responsible for negotiations of contracts or agreements which affect the application of incremental cost of fuel to daily operations is evident. ***AIEE paper, No. CP-57-1058***

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources. Order paper from source, not POWER.

American Institute of Electrical Engineers (AIEE), 29 W 39th St, New York 18, N. Y.

American Power Conference (APC), Illinois Institute of Technology, Chicago 16, Ill.



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Better Designed

Behind this Erie City "FT" package unit is the manufacturing skill and engineering know-how acquired through more than a century of producing large, high pressure, water tube and fire tube industrial power boilers.

The "FT" has five full square feet of heating surface (ASME basis) per developed horsepower. The 3-pass design places the gas vent at the rear where it belongs. Carefully proportioned gas areas through three lengths of the boiler take into consideration reduced gas volume as heat is being rapidly absorbed by the surrounding water. The "FT" is a pressurized unit using forced draft to provide precise control of excess air and CO_2 — no leakage of outside air into the combustion chamber is going to lower the efficiency.

Better Built

The same modern shop practices and quality workmanship used on our largest power boilers are used on these package fire tube steam generators. Every "FT" is of welded construction, stress relieved and X-rayed as part of the quality built into this unit. The "FT" is built for easy installation and complete accessibility. A full length, rigid, all welded structural steel base carries the entire package unit, permitting quick and easy installation anywhere without the use of skids and without excavation or foundation work. The front and rear heads are constructed of insulated, sectional panels for complete accessibility to the tubes and combustion chambers.

Every Erie City "FT" is built to highest quality — not down to a price.

Better Serviced

Every "FT" is designed, built, assembled, piped, wired and *Factory Fire Tested* by Erie City Iron Works. A complete package steam generator ready to go to work when it reaches the customer's plant.

A *factory trained* Erie City field service engineer will supervise the initial start-up and will instruct the operating personnel in the proper operation of the unit. This feature of using *factory trained* service engineers plus *Factory Fire Testing* results in a correctly adjusted, efficient steam generator.

Investigate all the advantages of the Erie City "FT" package fire tube. Catalog literature is available and an Erie City District Sales Agent will be pleased to show you an "FT" in operation.

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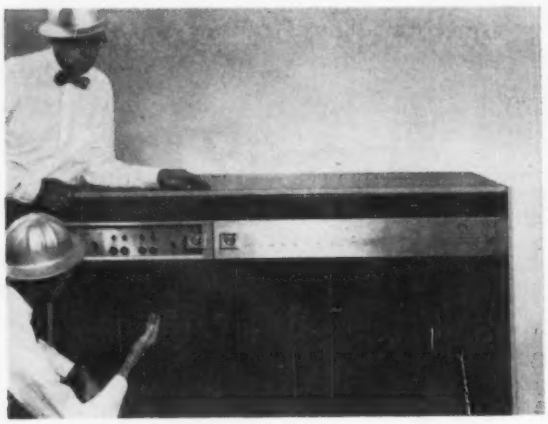
Plant equipment news

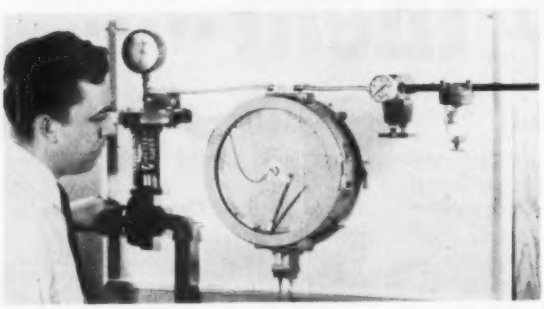
Your information center for new products and materials



Process-control system is computerized

1101 • A full range of process control, from simply providing information for an operator to evaluate, to completely automatic control of the entire process, is available with this system. Gradual changeover from manual process control to a completely automatic, computer-controlled plant is possible.

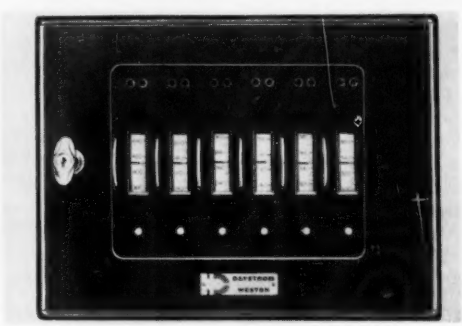
System can be connected to existing equipment. Developed around a rapid-response computer, it can be adapted to expanding functions as new instruments, techniques are developed. Computer unit is designed to cope with many variables, the need for intermittent information storage, and rapid computation, according to manufacturer.—*Librascope Incorporated, Glendale, Calif.*



Pneumatic recording controller is low-cost

1102 • Temperature recorder and controller unit for industrial applications uses a 15-lb air line to actuate an air-operated steam valve. It comes in ten temperature ranges, running from –30 through +1100 F.

The 10-in. circular chart is electric or spring driven for 24-hr, 48-hr or 7-day periods. Throttling range is said to be readily adjustable, 3-20%. Instrument is actuated by a mercury-filled thermal element.—*The Partlow Corporation, 508 Campion Rd, New Hartford, N. Y.*



Fully flexible controller fitted with new constant-current source

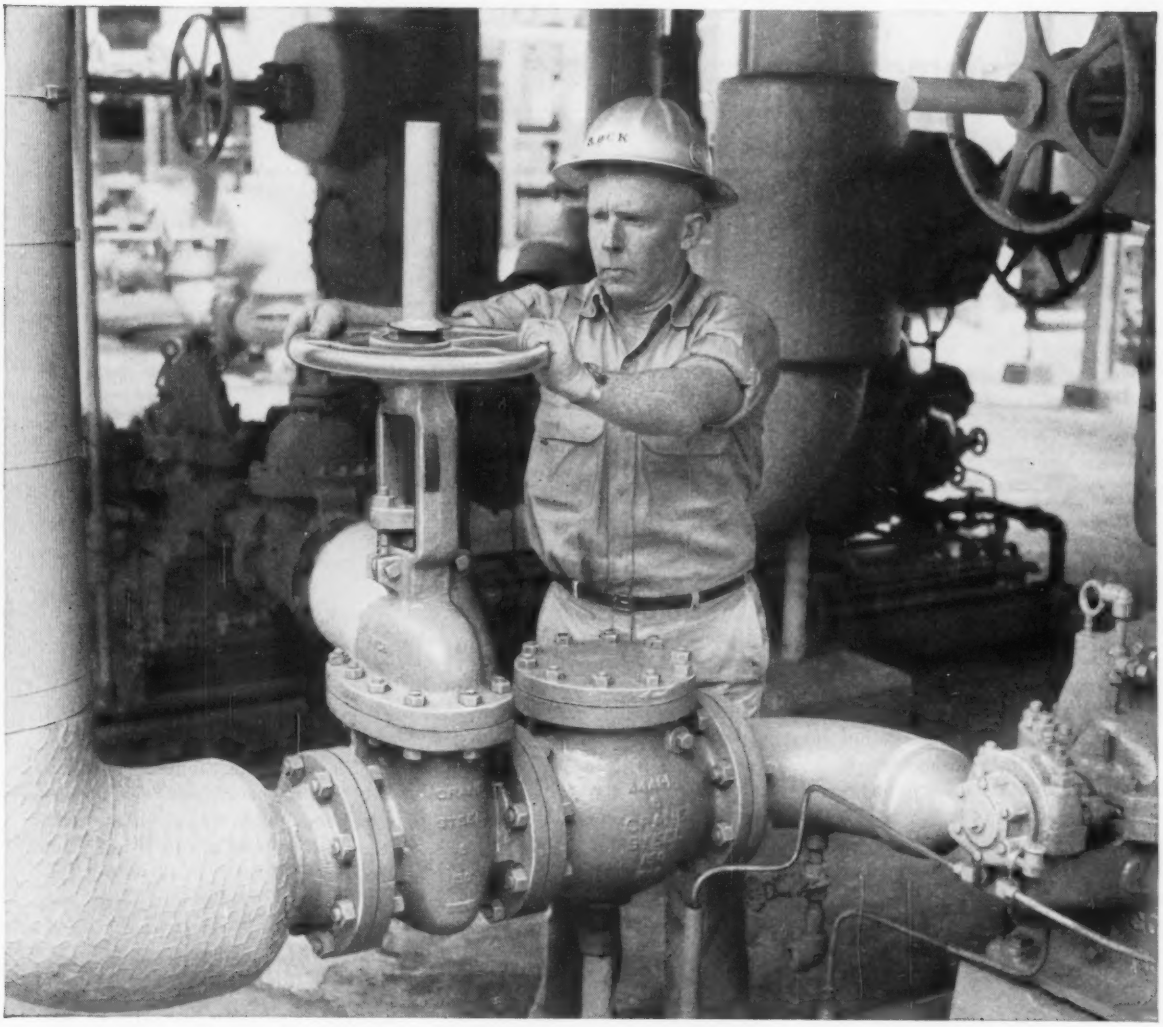
1103 • Multipoint non-indication controller, right, is useful where continuous control is necessary, but a chart record isn't needed. Unitized construction makes it possible to add or subtract control units at will for 1-, 2-, 3-, 4-, or 6-point operation.

Controller has an electronic amplifier, operates on the null-balance principle. A special switching arrangement lets instrument work with only one amplifier.

Another feature is the use of a potentiometer constant-current source, shown at left. This eliminates need for batteries, standard cell and standardizing mechanisms. Source is adjusted to an initial accuracy of 1/20%, according to the manufacturer.—*Daystrom, Inc, Daystrom-Weston Industrial Div, Newark, N.J.*

For more data on these items, use the post cards on page 153. Identify your request with item number

Gasoline Plant Cuts Valve Maintenance Costs



Crane Valves Do the Job After Others Fail

Six years ago this large gasoline plant in the Southwest, installed new gate and swing-check valves on hot water pump lines handling boiler make-up water.

Bonnet joint leaks and seat leakage developed after a short time. Maintenance costs jumped. After many attempts to stop the leakage, the bonnet joints were welded shut.

Two years ago the valves finally had to be replaced. Six-inch, 150-pound Crane steel gate and swing-check valves were installed. Today these Crane valves continue to operate without any leakage at bonnets or seats, and without a penny spent for maintenance.

Why are the Crane valves still operating *with* 100% efficiency and *without* maintenance? *It's Crane quality*—in design, materials and workmanship—that makes the difference!

For information about Crane steel valves for all services—power and process fluids handling—see your Crane Representative, or write to the address below.

IDEAS FOR YOU—This free book gives you 32 case histories of important savings with quality valves. Ask for "Valve Performance Facts."

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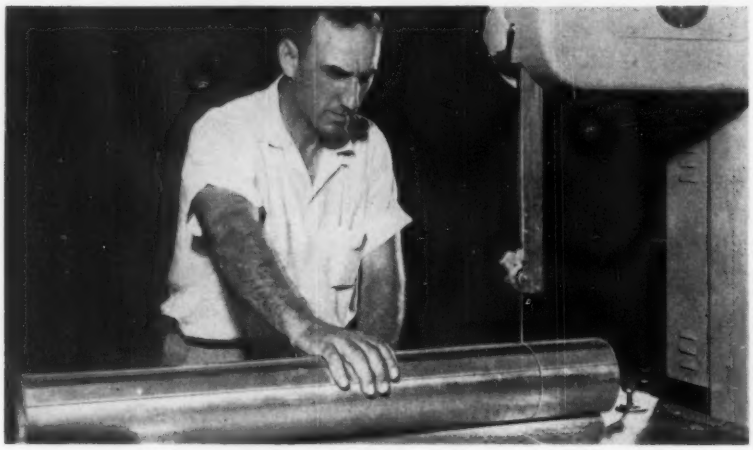
More **equipment news**



Insulation, jacket now combined for easy installation

1104 • Calcium silicate pipe insulation and aluminum jacket come in a single package, with installation time, carton to pipe, cut to 90 seconds. Designed for temperatures up to 1200 F, package is made up of .016-in. aluminum integrally combined with a vapor barrier and permanently attached to the insulation material. It comes in 36-in. sections in sizes up to 24-in. ID, 3-in. thickness. Insulation can be cut right on the job with a power or hand saw.—*Johns-Manville, 22 E 40th St, New York 16, N. Y.*

New materials lengthen life of 600-psi valve

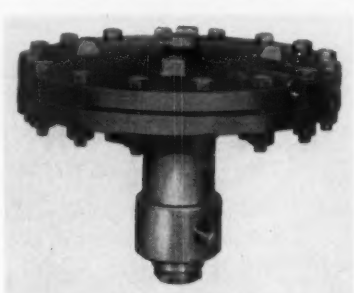
1105 • Globe valves for steam, oil, water and gas lines have disks made of chromium-cobalt-tungsten stainless-steel alloy for longer wear under continuous high temperatures. Units are rated 600 psi at 910 F in carbon steel, or at 1030 F in chrome-molybdenum steel.—*Edward Valves, Inc. 1230 W 145th St, East Chicago, Ind.*

For more data on these items, use the post cards on page 153. Identify your request with item number

Adaptable processing valves come with Penton lining

1106 • Available in cast iron or aluminum bodies, valves are lined with the chemically resistant plastic, Penton, a chlorinated polyether which can take temperatures up to 300 F.

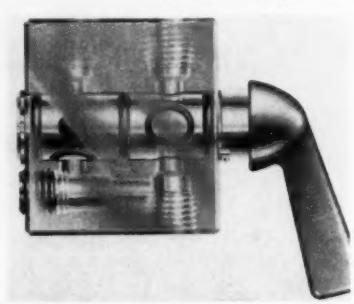
Valves are compatible with glass, plastic, metallic and lined piping. Size range is ½ in. to 6 in., with flanged ends only. Handwheel, quick-opening air or electric operators are available. Unit pictured is aluminum.—*Hills-McCanna Company, 4619 W Touhy Ave, Chicago 46, Ill.*



Large-ratio valve reduces 6000 to 100 psi

1107 • H-p reducing valve handles large-ratio pressures from 6000 psi initial pressure to outlet pressures from 100 psi upwards, to within 20% of the initial pressure in one stage. Unit is adapted for air, gas or hydraulic operation.

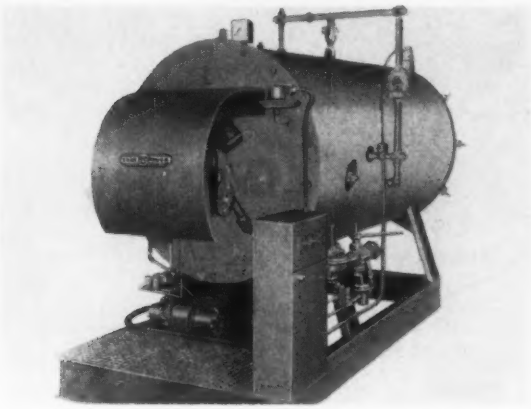
A small air reducing and relief valve charges a diaphragm chamber as a means of controlling the reduced pressure. Adjustment can be made from a remote point.—*Atlas Valve Co, 280 South St, Newark 5, N.J.*



Plug valve features leakproof shutoff

1108 • Leakproof shutoff, prevention of external and body leakage, minimum pressure drop are provided by 3-way plug valve. Sealing with O rings on the face of a cylindrical plug and on plug's diameter is said to produce easy operation and reduce maintenance. The general-purpose valve has three ports arranged as 3-way valves to provide one inlet, one outlet and an exhaust.—*Circle Seal Products Company, 2181 East Foothill Blvd, Pasadena, Calif.*

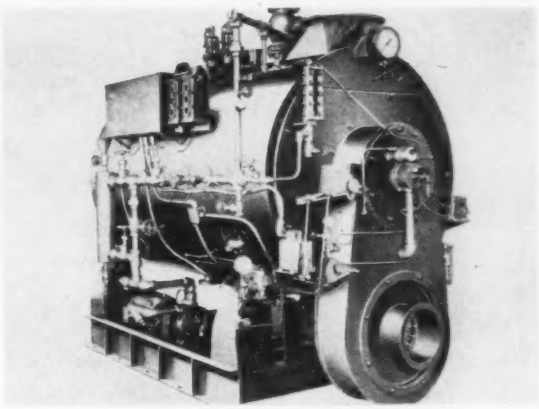
Begins on page 140



Boiler is built for hot-water systems

1109 • Automatic boilers will deliver continuous heat at varying rates of heat flow or intermittent heat at a fixed rate.

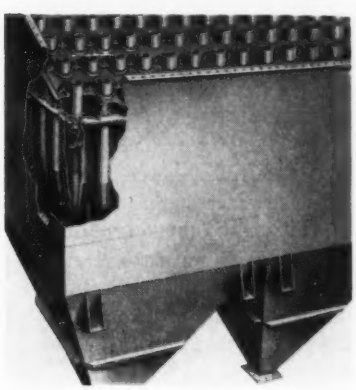
The line includes 14 models, with standard pressure of 30 psi, maximum temperature of 250 F. They burn light or heavy oil, gas, or gas-oil combinations. Features include (1) reverse flow with boiler on suction side of pump (2) an air-vent connection (3) blending valves (4) antishock control (5) low-water cutoff (6) all-welded and flanged piping, for quick field connections.—*York-Shipley, Inc, 500 Jessop St, York, Pa.*



Compact unit delivers 5000 lb per hr

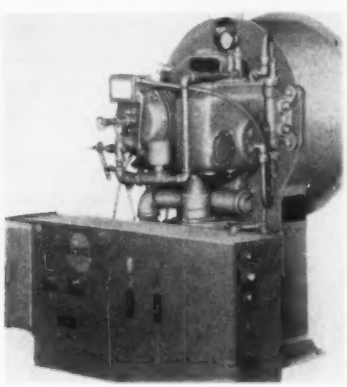
1110 • Dry-land adaptation of a marine steam generator can produce 5000 lb per hr in an 8x7 ft floor space. Unit is seven ft high, and modulates over a wide range, maker states.

Oil pump set assembly is factory-installed under the boiler, and water-treatment tanks are mounted on the side of the shell. Bypass piping allows manual control of water circulation. Unit is designed to government specs, and is said to be reliable and efficient under severe variations in operating conditions. It is electronically controlled.—*Cyclotherm, Oswego, N. Y.*



Collector is redesigned

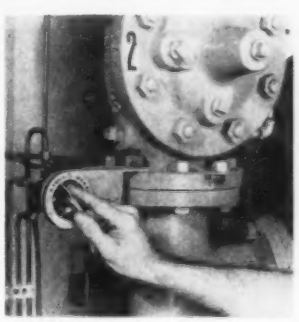
1111 • Uncleaned gases enter horizontally through a side inlet, and cleaned gases flow out through universal outlet in one mechanical dust collector redesign. In second new design, uncleaned gas enters collector through an inlet in top, leaves through a side inlet. Models come in three- to 336-tube arrangements. — *Research-Cottrell, Inc, Bound Brook, N. J.*



F-d burners are packaged

1112 • Small-capacity rotary type units are for application to multiple-pass scotch marine, watertube and firebox boilers, and for other types of heat receivers designed for pressurized operation. All burners are factory assembled, wired and tested. They feature electronic control.—*Ray Burner Co, 1301 San Jose Ave, San Francisco 12, Calif.*

Don't miss this item . . .



Master control valve ..... p 156

. . . or other product news appearing on following pages

Exotic-liquid filters	p 156
Low-resistance ohmmeter	p 158
Gas-valve lubricant	p 158
Bulk-bin level control	p 160
Tank suction bell heater	p 160

George Edwards

says, "Don't kill the goose that might lay a golden egg"

The whole world thrilled recently (though there may have been mixed emotions behind the Iron Curtain) to the exploits of our nuclear-powered submarines *Nautilus* and *Skate* under the polar icecap.

Without chipping a sliver from the admiration we all have for the skippers and crews of these boats, I'd like to focus on the man who made the whole business possible: the Navy's Vice-Admiral Rickover.

This man's life is a tremendous study in what brains coupled with guts can do to get things done in the face of rough odds. A target for bureaucratic weight-throwing and social prejudice for years, Rickover never let this slow his drive for sharper output from himself for the Navy.

An assignment to Oak Ridge came up for grabs. Other Navy men didn't want it, were satisfied with the status quo. But not Rickover. Though the job had the earmarks of a skull-buster, he applied for it. To him it spelled a real opportunity to come to grips with the power potential offered by the atom. It was a thankless job at best. But, despite this and kicks in the teeth by obstructionists, he stuck to his clear-headed concept of a nuclear-powered Navy. Today, I think he's entitled to wear a sardonic smile, but he's too busy with the future.

Remember Billy Mitchell? He was court-martialed because he was ahead of his time. But our military aviation technology is years ahead because of him.

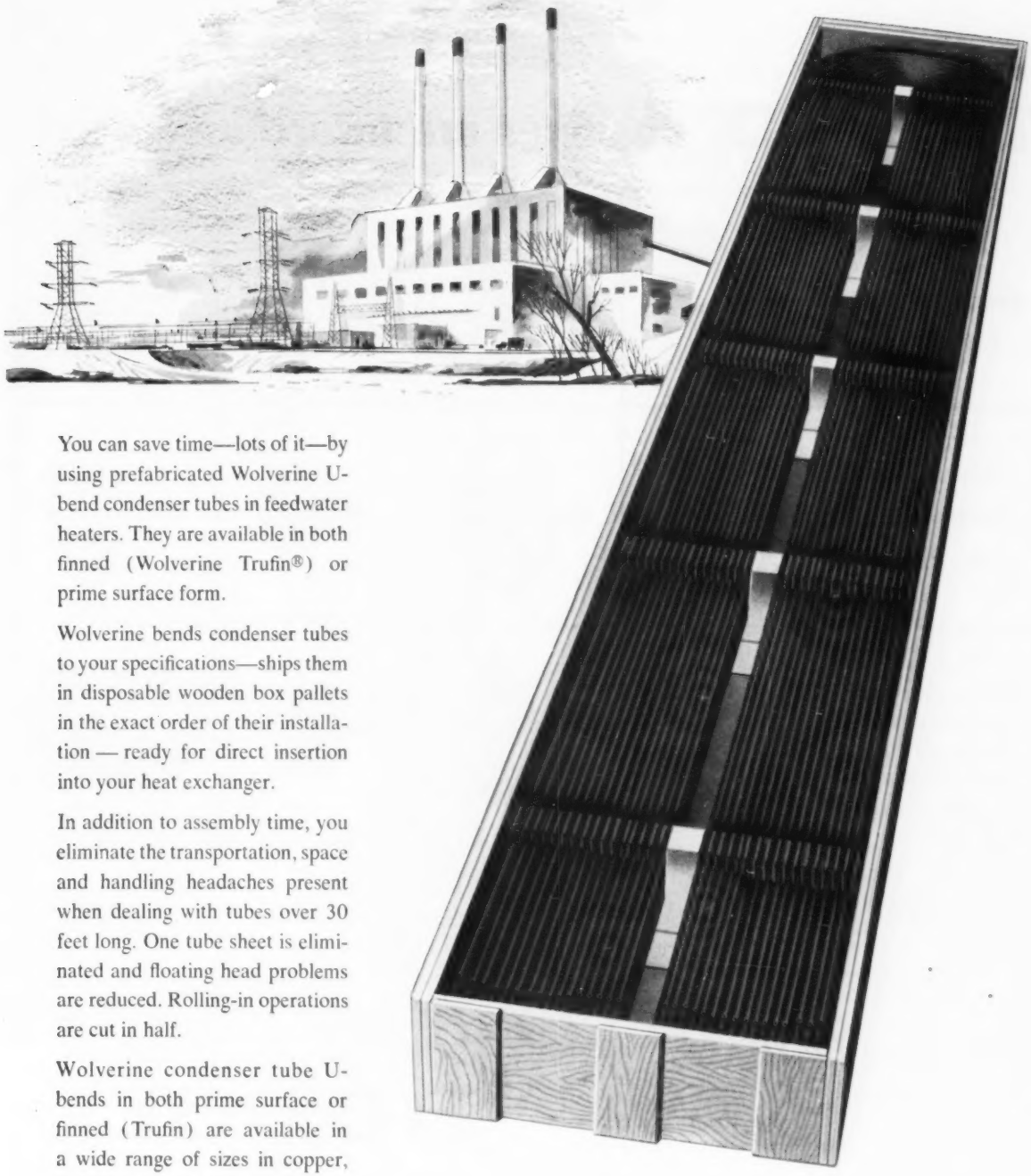
There have been other men who were willing to sacrifice everything—and many did—to bring about a better world for all of us. Medicine had its Semmelweiss, for example. And electronics had its DeForest, who was arrested as an alleged swindler while trying to develop his vacuum tube. And so on.

So what does this all mean to us in the power plant field today? Simply this: How many Rickovers, Mitchells and DeForests have been and are being smacked down by engineering management brass? A lot of the "I'll do the thinking around here" attitude has disappeared from management's makeup these days, it's true. But there are still too many plants where a guy is afraid to come up with some original thinking. Too many places where the boss has to think of it first or it's no good.

It's no problem to pick out the guys who are convinced that they've perfected the perpetual-motion machine. But let's not confuse these guys with our Rickovers and crush real talent in the process. Management that does this is headed for a seat in the "also-ran" section.

The same goes for the engineer who generates a worthwhile idea, but throws in the towel the first time he's belted by opposition. There's no pat formula for coming out on top, but Rickover is living proof of what can be done by being *sure* of your ground—and being willing to battle for it.

TUBULAR TIME SAVER



You can save time—lots of it—by using prefabricated Wolverine U-bend condenser tubes in feedwater heaters. They are available in both finned (Wolverine Trufin®) or prime surface form.

Wolverine bends condenser tubes to your specifications—ships them in disposable wooden box pallets in the exact order of their installation — ready for direct insertion into your heat exchanger.

In addition to assembly time, you eliminate the transportation, space and handling headaches present when dealing with tubes over 30 feet long. One tube sheet is eliminated and floating head problems are reduced. Rolling-in operations are cut in half.

Wolverine condenser tube U-bends in both prime surface or finned (Trufin) are available in a wide range of sizes in copper, copper alloy and aluminum. Write today for complete information.

See Wolverine's exhibit at the 14th International Heating and Air Conditioning Exposition, Philadelphia, Pa., January 26-29.

Wolverine Trufin is available in Canada through the Unifin Tube Division, London, Ontario.

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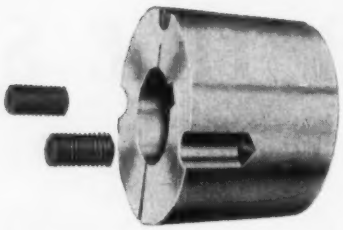
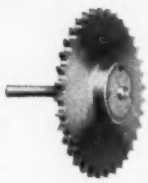
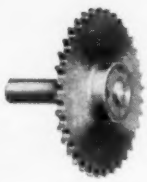
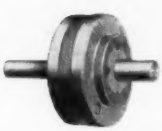
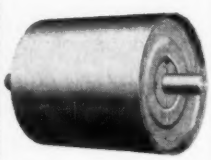


TAPER-LOCK Bushings are *Interchangeable!*

Change from shaft to shaft				
Change from size to size				
Change from sheaves to sprockets to couplings to conveyor pulleys				

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There's nothing like Taper-Lock for mounting wheels on shafts! First, you get off-the-shelf convenience. No reboring, no machining, no waiting!

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You save big money by minimizing down-time with *quick* changes. And interchangeability minimizes inventory. Note that all of the above installations are handled with a total of only four bushings—all with the same outside diameter!

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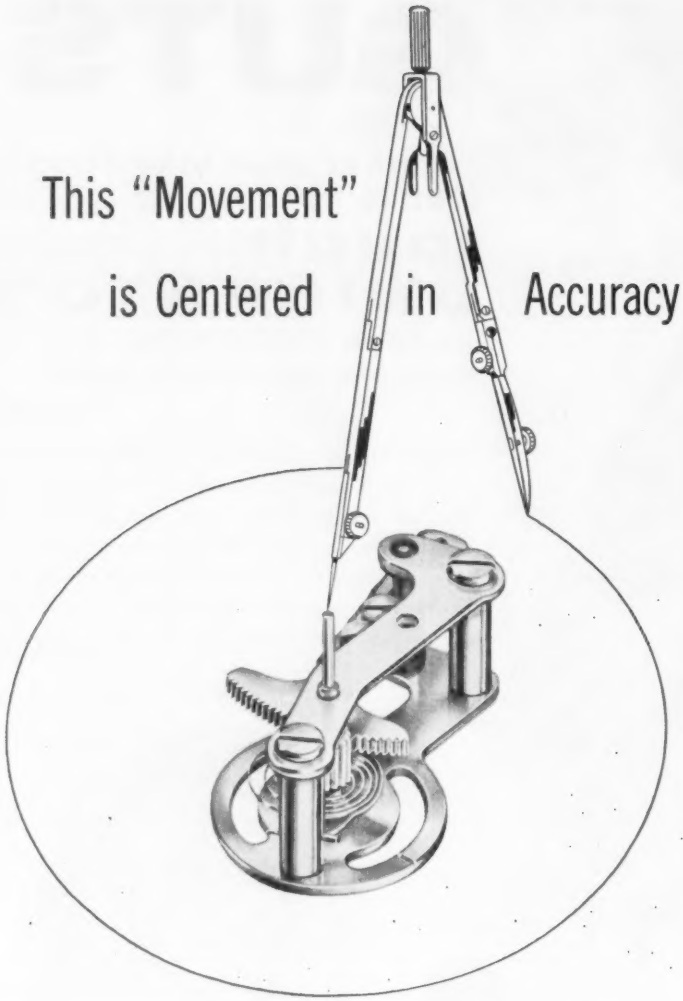

The rotary movement in Ashcroft Duragauges has a geared center shaft on which the pointer is mounted. When pressure flexes the Bourdon tube, the pointer is always positively positioned. You can rely on the Duragauge for precise accuracy in measuring pressure no matter how severe the conditions of service.

Correct calibration is guaranteed: the one-piece link between movement and Bourdon tube prevents slippage or parting under tension. Recalibration is easy from front or rear. Universal adjustability permits uniformly graduated dials.

You can order Ashcroft Duragauges with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A complete choice of Bourdon tube materials, pressure ranges, dial sizes and case designs and materials is available. Your industrial supply distributor will gladly help you select the best combination for your requirements. So, be certain of highest sustained accuracy, durability and economy – specify Ashcroft Duragauges.

Ashcroft Duragauge in Alumalife® case—a lifetime case made of special aluminum alloy.

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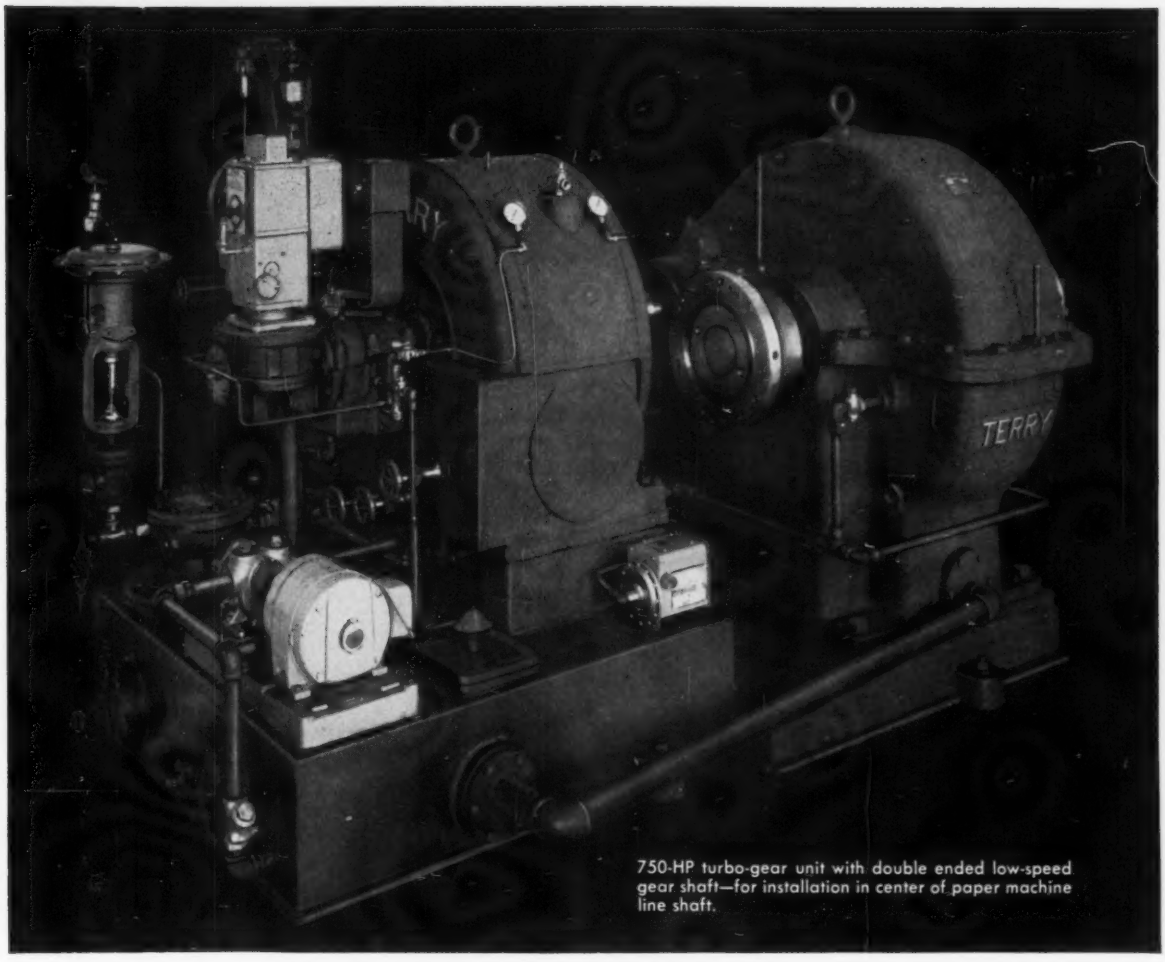

750-HP turbo-gear unit with double ended low-speed gear shaft—for installation in center of paper machine line shaft.

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tailored to meet your requirements

For more than half a century, Terry has been one of the principal suppliers of turbo-gear units for driving slow-speed fans, generators, paper machines, large pumps and the like. Each unit is designed to meet the job requirements. The paper-machine drive illustrated is a good example of this *individualized engineering.*

In service at a large southeastern paper mill, the unit delivers 750 HP at 3350/500 RPM, with steam conditions of 450 lbs., 660°F and 50 lbs. back pressure. Equipped with a variable-speed governor, operated by remote control, the speed of the unit may be varied through a 10:1 range. Other features include forced-feed lubrication to turbine and gear bearings, and automatic shutdown and alarm in case of low oil pressure.

Whatever *your* requirements for low-speed turbine drives, a Terry engineer will be pleased to discuss them with you. Bulletin S-140 covers the full line of Terry turbines; Terry gears are described in bulletin S-130.

THE TERRY STEAM TURBINE CO.
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TT-1212

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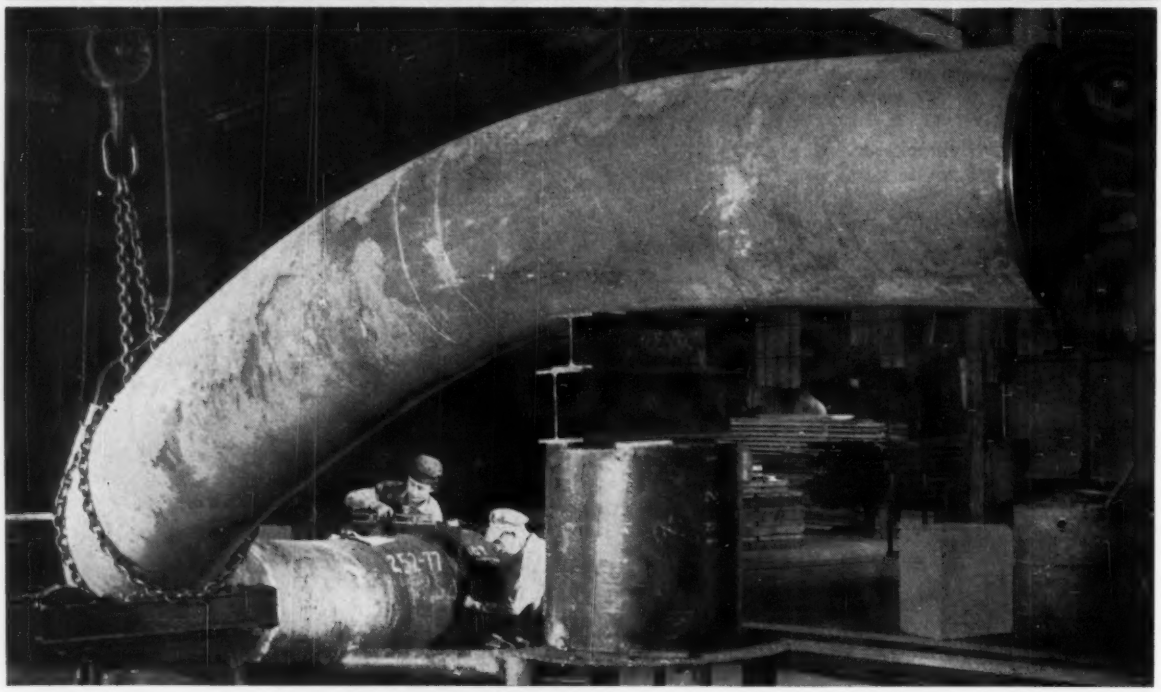
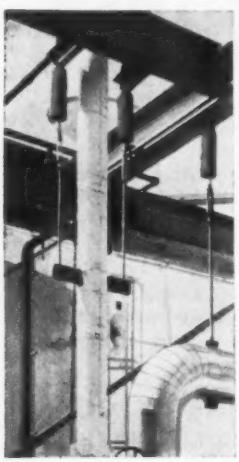


Large chrome moly pipe being readied for shipment to new generating station. Making a right angle bend followed by a 24 degree, 18 foot bend in this heavy 27½ inch chrome moly pipe required all the skill and modern facilities of the Blaw-Knox power piping shop. Before shipment, piping is heat-treated and ultrasonically tested with a radar-type device for detection of any defects.

A new Blaw-Knox "6 x 6" Flexibility Matrix Method of computing stresses in power piping systems is now available to consulting engineers, companies, and individuals responsible for the design of power piping systems. By the use of an electronic computer this method cuts calculating time from months to a day; assures full accuracy to six significant figures; and has no limitations on the complexity of the system. Write for further information about our new "6 x 6" Flexibility Matrix Method.



Two-way control over movement of piping is provided by Blaw-Knox functional spring hangers with the patented internal swivel action—shown in this modern outdoor generating station. Our experienced engineers are available to both design and make recommendations for your hanger requirements. To get full information, write for Catalog No. 54.

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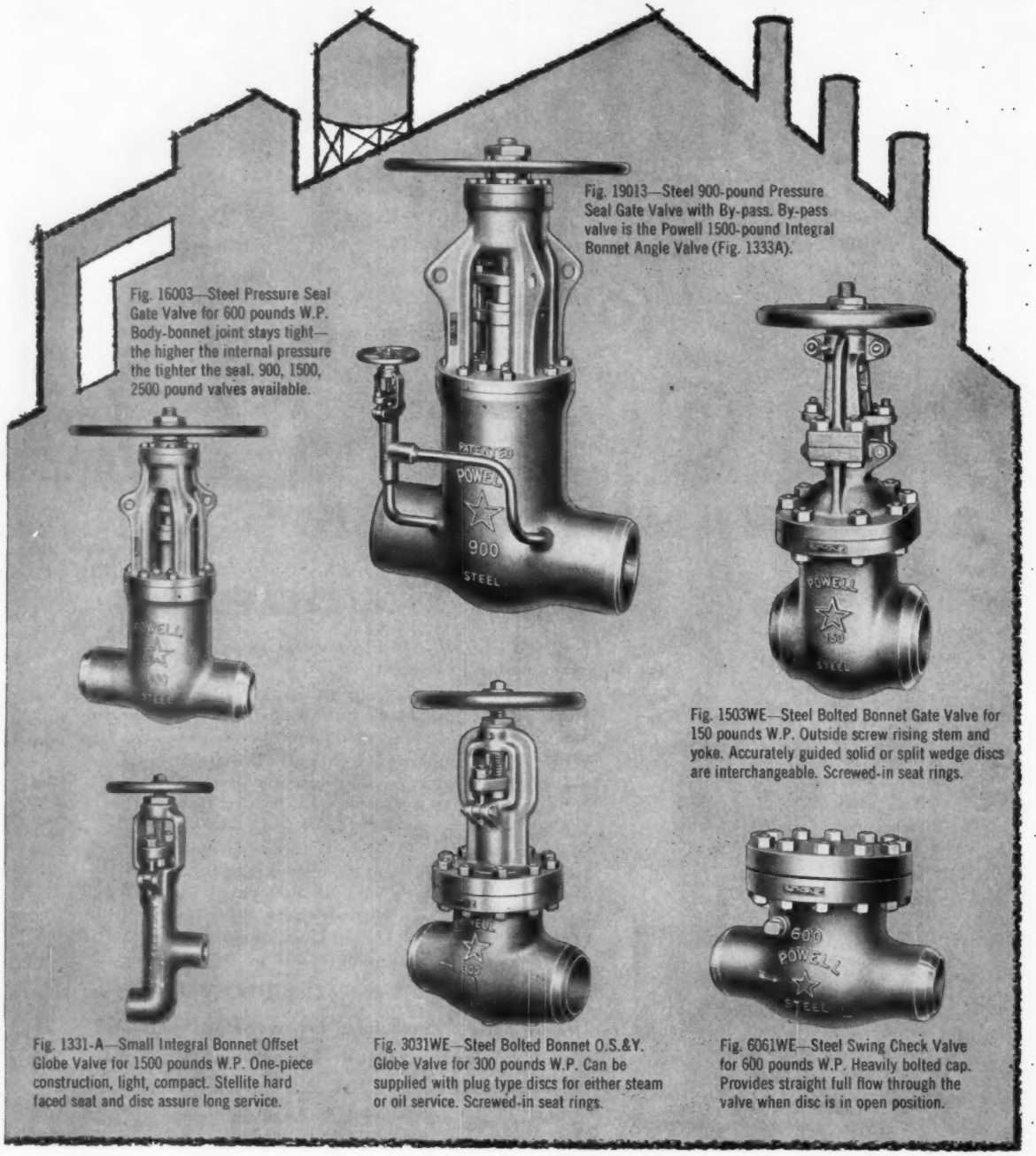

Fig. 19013—Steel 900-pound Pressure Seal Gate Valve with By-pass. By-pass valve is the Powell 1500-pound Integral Bonnet Angle Valve (Fig. 1333A).

Fig. 16003—Steel Pressure Seal Gate Valve for 600 pounds W.P. Body-bonnet joint stays tight—the higher the internal pressure the tighter the seal. 900, 1500, 2500 pound valves available.

Fig. 1503WE—Steel Bolted Bonnet Gate Valve for 150 pounds W.P. Outside screw rising stem and yoke. Accurately guided solid or split wedge discs are interchangeable. Screwed-in seat rings.

Fig. 1331-A—Small Integral Bonnet Offset Globe Valve for 1500 pounds W.P. One-piece construction, light, compact. Stellite hard faced seat and disc assure long service.

Fig. 3031WE—Steel Bolted Bonnet O.S.&Y. Globe Valve for 300 pounds W.P. Can be supplied with plug type discs for either steam or oil service. Screwed-in seat rings.

Fig. 6061WE—Steel Swing Check Valve for 600 pounds W.P. Heavily bolted cap. Provides straight full flow through the valve when disc is in open position.

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STEAM GENERATION

1 **Packaged boilers,** 3-pass rotary f-d and pressure f-d units, are subject of 8-p bulletin 34-B-1. Includes complete specs, photos, diagrams. Webco Boiler Co, Inc, 1 Vanderbilt Ave, New York 17, N. Y.

2 **Horizontal boiler** available for use with gas, oil or gas and oil is discussed in 4-p booklet 8-C. Describes features, gives specs and cutaway view. Mears-Kane-Ofeldt, Inc, Bridgeport, Pa.

3 **Deaerating feedwater heaters,** baffle spray type units, are topic of 6-p bulletin S-217. Includes cutaway, step-by-step operating description, review of counter-flow principle. Stickle Steam Specialties Co, 2215 Valley Ave, Indianapolis 18, Ind.

4 **Packaged deaerating heater** for the smaller steam-generating plant comes in capacities from 2800 lb per hr to 100,000 lb per hr. Bulletin WC-118A, six pp, includes a chart giving sizes, dimensions, space requirements, complete specs. Graver Water Conditioning Co, 216 W 14th St, New York 11, N. Y.

5 **Dry purifier** capable of removing 99.9% of all solids entrained in hot-gas streams is described in 4-p brochure 600. Centrifix Corporation, 3608 Payne Ave, Cleveland 14, Ohio.

ELECTRICAL TRANSFORMATION

6 **Sealed, dry type transformers,** aluminum-wound light-weight units, are subject of 8-p bulletin GEA-6790. Includes standard and optional features, photos, charts, graphs, block diagrams. General Electric Co, Schenectady 5, N. Y.

7 **Dry type air-immersed self-cooled transformers** are described in spec sheet. Covers construction points for single and 3-phase distribution and power units. Precision Transformer Corporation, 2218 W Lake St, Chicago 12, Ill.

8 **Distribution equipment** transformers rated 112½ to 500 kva are described in 4-p bulletin GEA-6832. Gives lists of terminations, standard accessories, weight and dimension tables. General Electric Co, Schenectady 5, N. Y.

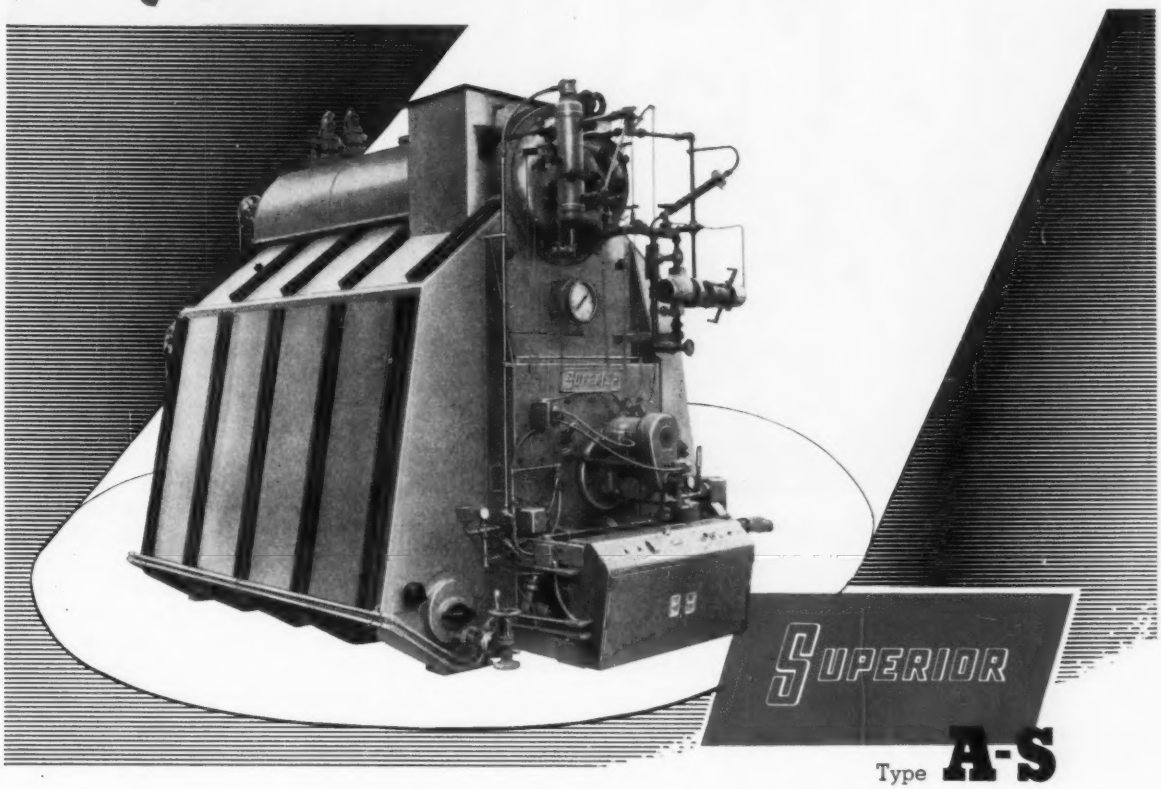
ELECTRICAL DISTRIBUTION, PROTECTION

9 **Underfloor duct** systems and component parts are topic of 20-p catalog 758. Two sizes of duct, eight junction boxes, various fittings are listed. Includes 11 pages of dimensional drawings. Walker Brothers, Conshohocken, Pa.

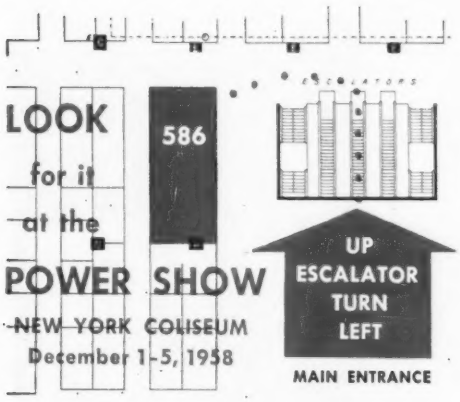
(Continued on page 202)

IN THE SPOTLIGHT AT THE POWER SHOW...

A *New* WATER-TUBE BOILER



for capacities as low as 4,000 lbs./hr.



Look for it at the Power Show. Superior's newest addition to its complete line of fully packaged boilers . . . a unit designed for those whose requirements, even for low capacity ratings, can only be met by a water-tube boiler.

From its highly efficient, fully automatic rotary burner with integral combustion control, to its rear-mounted mechanical draft fan providing positive air-cooled furnace floor, the Superior Type AS brings to low capacity boilers all the advantages of water-tube design, in a unit designed for sustained efficiency, safety, and high availability.

Make sure you see this outstanding boiler at Booth No. 586.

Literature on the Superior Type AS is now available and may be had by writing for Bulletin 1000-S.

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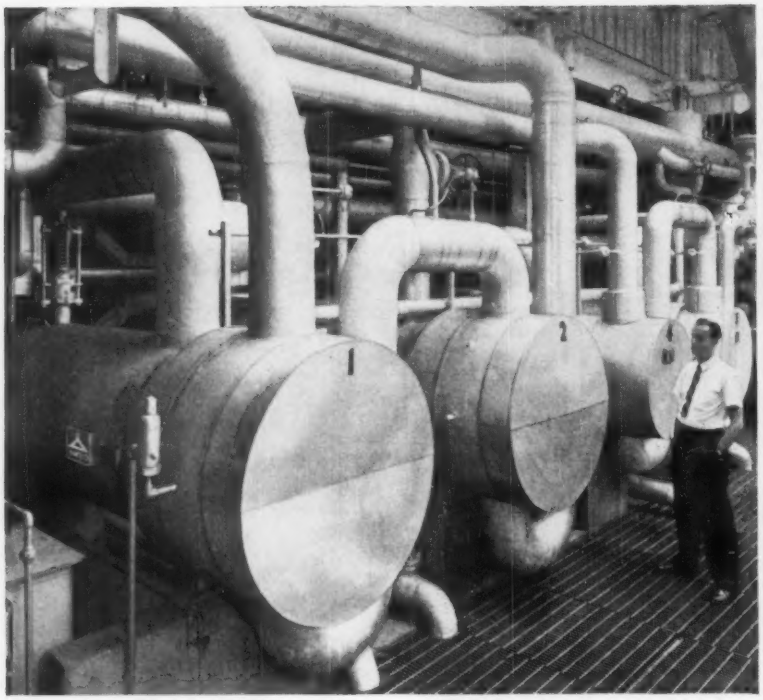


Four SWECO feedwater heaters (two high-pressure and two low-pressure) in 44,000 KW unit at Broadway Steam Plant, Light and Power Department, Pasadena, California

No concern – about these seal-welded feedwater heaters

Continuous trouble-free high pressure operation assured by SWECO's exclusive "pre-stressed welding".

The channel closure of every SWECO high-pressure feedwater heater is seal-welded under pressure – half again as great as the designed operating pressure. Thus, when the unit is delivered and placed in actual operation, the stress in the closure weld is largely eliminated, providing trouble-free performance throughout the heater's long service life.

The two high-pressure feedwater heaters in the Pasadena plant (left in photo above) were even installed without shutoff valves or bypass, because department engineers decided that the reliability of SWECO all-welded heaters is greater than that of valves. The units have now been in continuous operation more than a year – with load swings between 10,000 and 20,000 KW, 5 to 10 times a day – with corresponding variations in pressure and temperature – but with no trouble, no concern.

For your copy of the new bulletin on exclusive pre-stressed welding process and other quality features of SWECO feedwater heaters, write for Bulletin M-11-393.

More than 40 years service to the process and power industries.

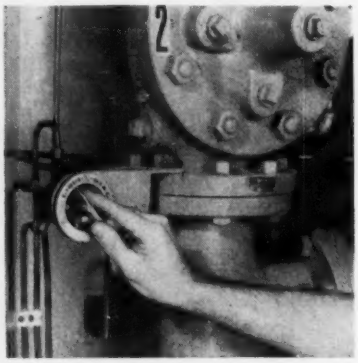
SWECO

Southwestern Engineering Company

4800 Santa Fe Ave., Los Angeles 58, Calif.
Engineers–Constructors–Manufacturers

Equipment news

Begins on page 140



Master control valve

1113 • Complex industrial and water conditioning processes can be regulated by the turn of a dial, according to manufacturer. Control uses hydraulic pressure to actuate as many as 36 remote valves from one location, turning them on and off according to any preset sequence.

The process itself may often be used as a pressure source to actuate control valves. Pressure, acting through small pilot valves, holds valve disk assembly closed by pressing on a flexible diaphragm. Control opens the valves by interrupting this pressure, venting a pilot tube.—*Automatic Valve Systems Co, 1535 Monrovia Ave, Newport Beach, Calif.*

For more details on these items use post cards p 153. Identify your request with item number.

Filters for exotic liquids

1114 • *Code* designs, corrosion-resistant materials and elimination of dead thread spaces and unvented

O-B VALVES

New O-B regrinding swing check valves ONCE IN...THEY STAY IN

There is no need to replace a swing check valve every time the closing surfaces become worn. This new O-B valve can be reground right on the line... your service is interrupted for just a matter of minutes. The "Y" design makes it easy to do the regrinding... or to get to the disc when it needs changing.

Free-swinging action of the hanger assembly permits the disc to clear the entire port under pressure and to close tight at the slightest back pressure. Because two side plugs, instead of the usual one, are provided, the hanger pin and assembly can be removed even when the valve is mounted close to an obstruction.

O-B Regrinding Swing Check valves are available in sizes from ¼ through 3 inches for 150 lbs. WSP—300 lbs. WOG and 200 lbs. WSP—400 lbs. WOG.

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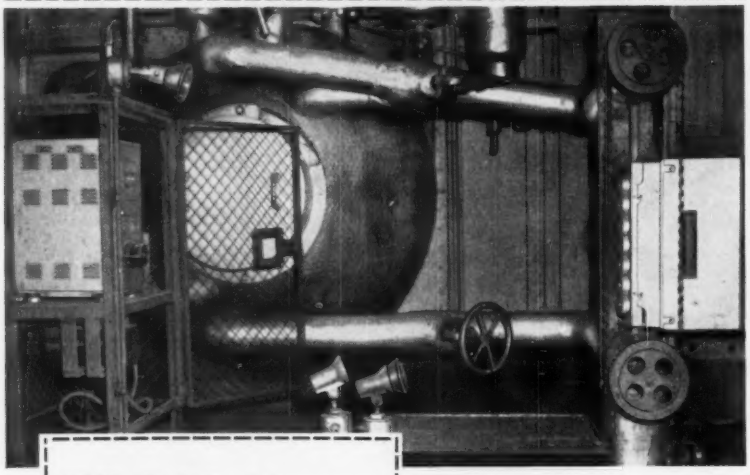
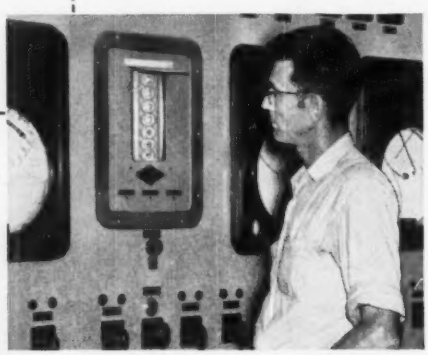


Diamond Television camera has been SEEING water level in boiler for almost nine years.

75,840 Hours of Operation

(with Original Camera Pickup Tube)



Operator at boiler board SEES boiler water level on Diamond Television screen.

At the Wood River Station of the Illinois Power Company, this Diamond "Utiliscope" has been in continuous operation since 1949. It has a job where dependability is all important: watching the water level in a big central station boiler. The original camera pickup tube is still in service . . . a record of more than 75,840 hours (nearly nine years) of operation. Routine maintenance is the only service required since installation.

Diamond "Utiliscope"—Heavy Duty Television—is dependable, durable, resistant to time and difficult operating conditions. It is saving money and improving operation in steel mills, foundries, mines, and a wide variety of manufacturing plants. Use the coupon below to obtain more information.

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Please send me without obligation a copy of bulletin showing how Diamond Industrial Television will help me reduce costs and improve operations.

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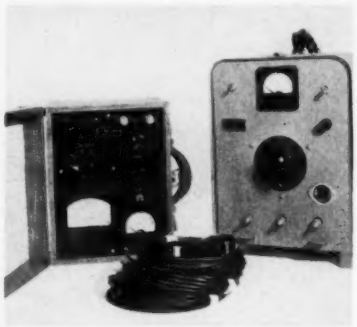
Equipment news

Begins on page 140

pockets are said to make these filters reliable for unstable-liquids systems. Units are suitable for use with exotic fuels and components, including hydrogen peroxide, hydrazine, ethylene oxide and liquid oxygen.

A furnace-welded wire-mesh filter medium is used, and can withstand full system pressure in case of clogging without collapsing, maker states. Collected solids can't reach downstream areas.

Large units in photo handle 5000 gpm of LOX, removing all particles over 40 microns in size. Small element filters 30 lb per min of nitrogen with a 10-micron retention rating.—*Pall Corp, Micro Metallic Div, 30 Sea Cliff Ave, Glen Cove, N. Y.*



Low-resistance ohmmeter

1115 • Test set measures resistance values as low as one microhm, within 2% accuracy, according to manufacturer. Set consists of a microhmmeter plus a transistor type rectifier for supplying both a 10-amp dc and a 100-amp dc source. Meter also has a self-contained 10-amp battery power supply where power lines are not available or are de-energized.

Unit checks condition of oil and air circuit-breaker contacts and current paths from bushing terminals without disassembling.—*J W Dice Company, Englewood, N. J.*

For more details on these items use post cards p 153. Identify your request with item number.

Gas-valve lubricant

1116 • New lube was developed and tested to meet gas associations' requirements. It is a h-t, non-melting-point grease fortified with highly purified molybdenum disulfide powder. Grease is recommended for use

These 5 "tips" can help you end sump pumping problems *once and for all*

Here are 5 ways to prevent sump pumping trouble before it starts *and* cut maintenance time—with Goulds Fig. 3171 vertical centrifugal sump pump.

1. Put the pump at the proper depth without paying the extra cost for special shaft lengths and pipe columns. Goulds Fig. 3171 fits any pit from 2 to 20 feet deep—comes in standard lengths of 6 inch increments.

2. Maintain pump alignment permanently by means of male and female fits on Goulds Fig. 3171.

3. Prevent damage by fumes, weather, moisture with these features of the Fig. 3171: completely sealed-in upper bearing; Falk all-steel couplings; special vapor-proof construction (upon request).

4. Make external adjustments for impeller clearance with Goulds Fig. 3171—to save time, trouble. Replace upper bearings without disturbing pump or piping merely by removing the motor and coupling from above.

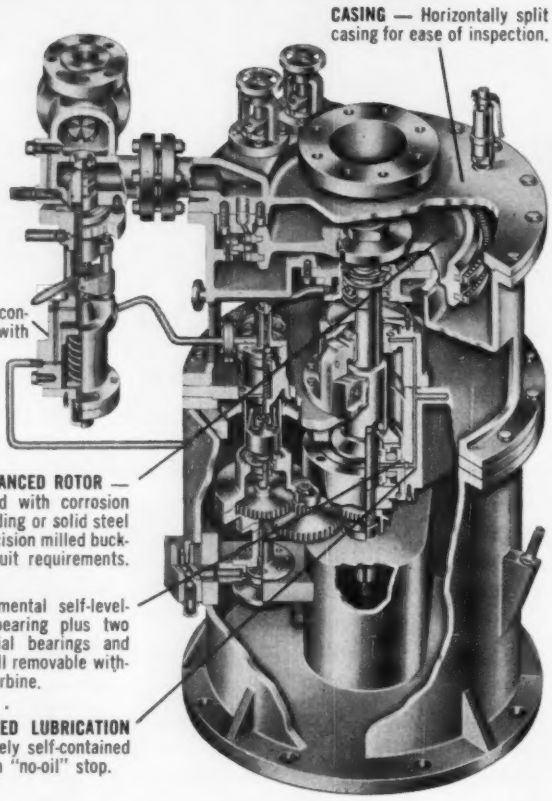
5. Adapt to changing pit depths without ordering a whole new unit. You can adapt this pump *in the field* for new depth or pump ratings simply by ordering a few new parts.

You can get Goulds Fig. 3171 as a single or duplex unit—completely assembled with sump cover—for wet or dry pits, with capacities to 1080 GPM, heads to 290 ft. For more details, contact your Goulds dealer, or write for your copy of Bulletin 726.2.

GOULDS PUMPS, INC.
Dept. PO-118 Seneca Falls, N. Y.

NEW Whiton VERTICAL TURBINE

Type BHBSV for Vertical Pump Drives


CASING — Horizontally split casing for ease of inspection.
SPEED CONTROL — Oil constant speed governor with overspeed stop.
DYNAMICALLY BALANCED ROTOR — Either steel forged with corrosion resistant steel blading or solid steel one piece with precision milled buckets available to suit requirements.
BEARINGS — Segmental self-leveling type thrust bearing plus two babbitt lined radial bearings and shaft packing — all removable without dismantling turbine.
FORCED FEED LUBRICATION — Completely self-contained system with "no-oil" stop.

The Whiton Vertical Turbine is extremely versatile, compact and dependable . . . ideal for vertical pump drives and other similar applications. The vertical design requires minimum installation space and allows great freedom of location. Simplicity of design and construction results in ease of operation and servicing.

With this vertical turbine added to the line, Whiton's vertical and horizontal steam turbines offer a broad range of power supply applications. Complete data on the new vertical turbine and others available on request.

MAXIMUM OPERATING SPECIFICATIONS	
POWER	to 1000 HP
SPEED	to 8500 RPM
STEAM PRESSURE	to 1250 PSIG
STEAM TEMPERATURE	to 1050° FTT

Whiton SINCE 1856

THE WHITON MACHINE COMPANY
NEW LONDON, CONNECTICUT

Equipment news

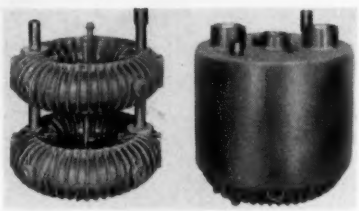
Begins on page 140

on plug cocks of metal, plastics or glass on equipment where reliable lube in presence of gases or liquids is required. It is said to eliminate gumming formations.—*The Alpha-Molykote Corporation, 65 Harvard Ave, Stamford, Conn.*

Bulk-bin level control

1117 • Level indicator-control has an easily removed cover and a fail-safe device. A 1/100-hp motor turns a 4-blade paddle at 9 rpm by means of a tortion spring. Standard unit works at 120-v 60-cycle ac.—*Convair, Pittsburgh 22, Pa.*

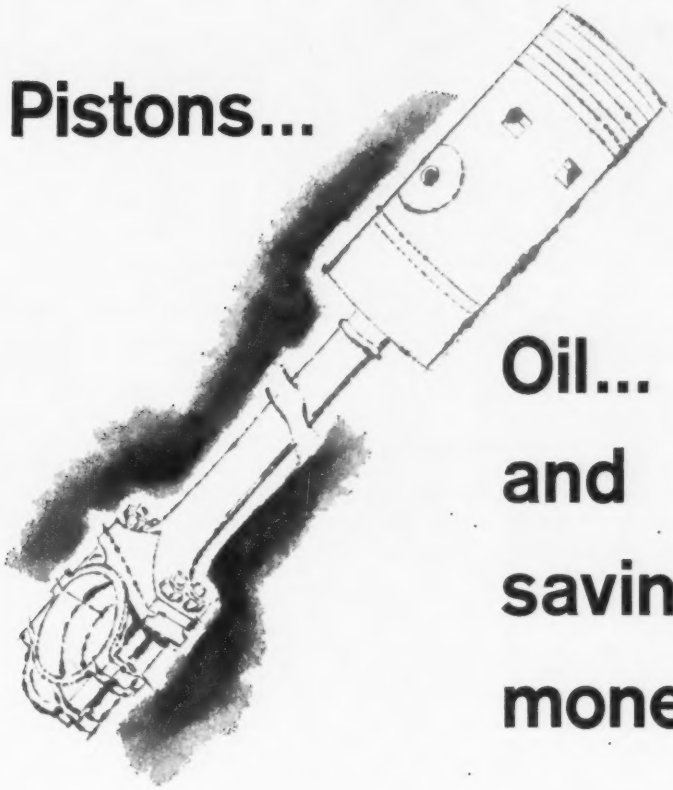
For more details on these items use post cards p 153. Identify your request with item number.



Tank suction bell heater

1118 • Unit has 12 sq ft of heating surface in a cylindrical bell 15¼ in. in dia by 16½ in. high. Designed to speed withdrawal of No. 6 fuel oil from tank storage, it can be passed through tank manholes as small as 16 in. Dome-shaped housing, right, is open at bottom to expose cast finned heating sections, left. Steam, hot water or heat-transfer liquids serve as heating media.—*Davis Engineering Corporation, 30 Rockefeller Plaza, New York 20, N. Y.*

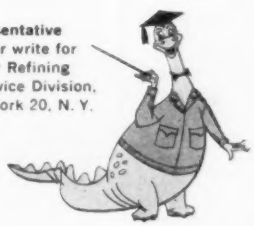
Pistons...



Oil... and saving money

The longer your pistons work before need of ring replacement—the less your cost of operation. Sinclair Rubilene® Oils have the reputation for giving longer service to cylinders, rings and other vital parts. Refill with Rubilene now. Next time management asks how you've cut costs, tell them you've switched to Sinclair—and show them the results.

Call your Sinclair Representative for further information or write for free literature to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. There's no obligation.



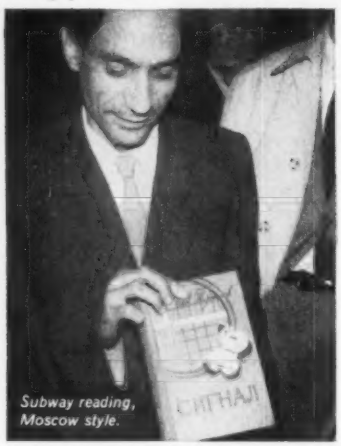
SINCLAIR
Rubilene® Oils

RAMBLINGS ON INSTRUMENTATION

The Mysterious East

(It's-a-Small-World Division)

(Mr. Sprague and beard have recently returned from a visit to the U.S.S.R. with the Automatic Control Delegation. Herewith, some ramblings from the borscht circuit.)



Subway reading, Moscow style.

The other day, when a group of us were on the way to the Hotel Ukraine via the Moscow subway, we ran into a serious type pouring over a volume 'midst the swaying bodies. Intrigued by his concentration, we asked through our interpreter, what he was reading. The reply: a book on Automatic Control and Cybernetics. Knowing that no one would believe us, we snapped the above photo.

Seriously, this incident symbolizes the intentness with which the Soviet appears to be focusing on the theory and application of instrumentation and control devices. It was my impression that their technology is moving rapidly and is not a "house of cards"; rather it is soundly based on rigorous training in theory and application, as well as continuing emphasis on the fundamental standards which are the cornerstone of all science.

While ours was but a fleeting (and Soviet-selected) glance at an enormous country, I got the impression that—borrowing heavily from German and American designs—the Russians have built an instrument and control industry which, with a few old Lend Lease exceptions, is supplying their plant requirements.

It would appear that the focus will continue to be on producing relatively standard instruments in large quantities to meet the tremendous demand created by their 5-year plans for rapid industrialization of the country. We were told that they anticipate the instrument and control industry to increase 2.8 times between 1956 and 1960.

But we got more than a hint of their relatively new interest in foreign markets. China, Czechoslovakia, India, Argentina and 26 other countries were mentioned. Using their hole cards of, (a) concentrating large volume production of a single item in a single plant and, therefore, achieving rapidly decreasing costs and, (b) arbitrary manipulation of their exchange rates, the U.S.S.R. can be expected to be a rugged competitor on the international automation scene very soon.

Should we shudder? No, but I do think we should supplement the drive or motivation (which has become rather jaded of late) toward conspicuous consumption of washers, dryers, TV sets, et al, with a more individual concern for the care and feeding of our human resources. Let's face it—this is a Brains Battle and we can work out solutions for the development—*our way*—of our people of talent only if we realize it is necessary.

And, on the international competition issue, let's do more of what comes naturally; i.e. continually obsoleting products by innovation and improvement . . . constantly posing "this model is better" choices for customers here and abroad, as (commercial plug) we are trying to do here at Hays with, for example, *this year's* new products: the Universal Recorder, the new 245 flow transmitter, the 913 BTU Recorder and a new approach to gas sampling systems. So let's over-estimate the competition and rediscover our greatness.

Phil Sprague Jr. President

THE HAYS CORPORATION • MICHIGAN CITY 3, INDIANA

Marmaduke

Continued from page 132

a lost land bird on a ship's mast.

"Bert got hot. After asking everyone questions, he learned that the generator's control panels had been moved a few weeks after the machine was installed. He also discovered that the electricians had not recalibrated the thermocouple leads going to the temperature indicators. That accounted for 6 or 7 C.

"He knew that at least one bearing in those alternating machines should be insulated because voltages are induced in the shaft. Without insulation, current flows through the babbitt to ground. I've seen that cause pitting, babbitt wiping and shaft etching. But, from what Bert said, his generator seemed to be properly insulated and grounded.

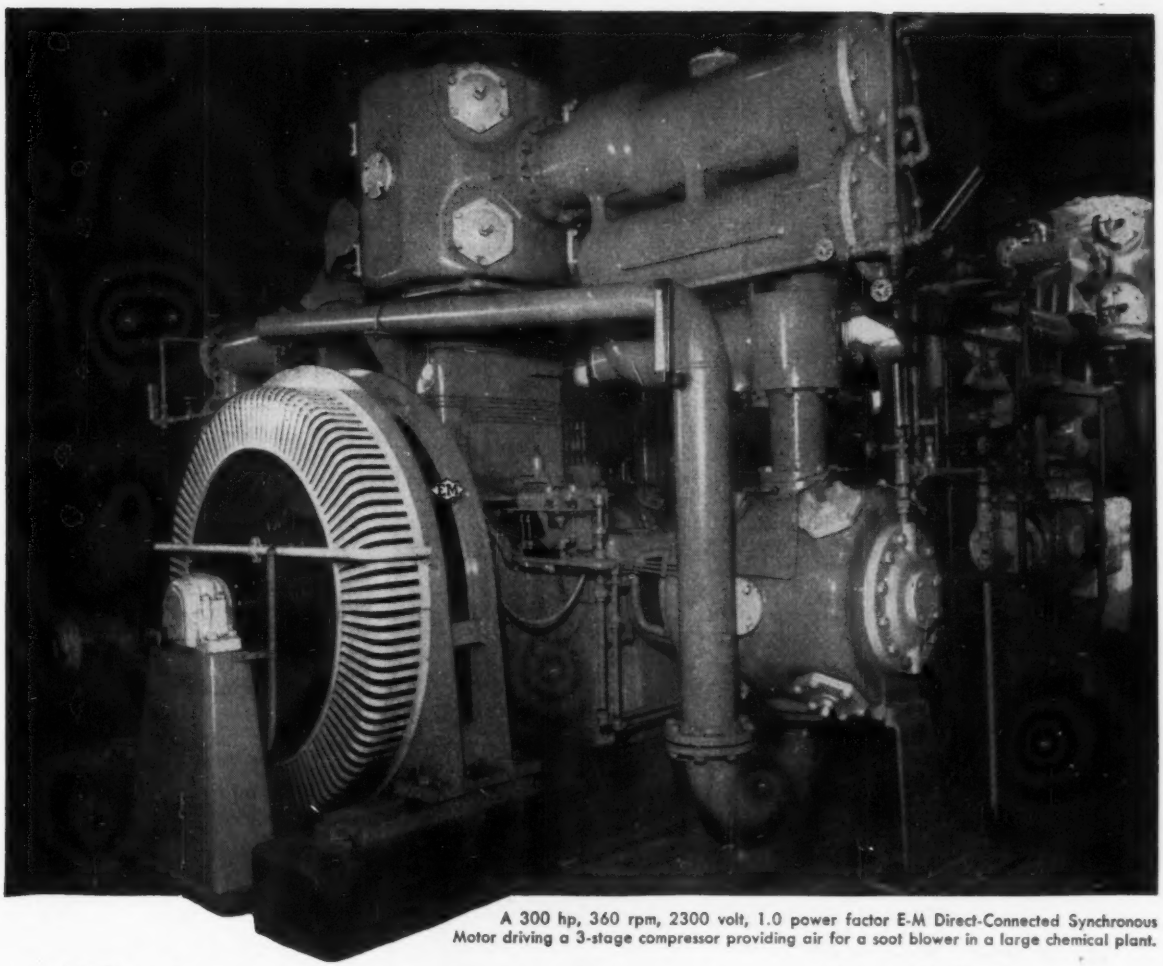
"Bert told me he ran a series of tests after installing extra thermocouples on bearing hot spots, cold spots, top and lower oil connections and, for good measure, on the intake and discharge water lines. During this work, his boys accidentally shorted out the insulation on one bearing. After startup, that almost ruined that bearing and the shaft.

"That's when Bert sent an SOS to the German manufacturer. They answered by sending Schultz down to straighten out that generator. He was their ace field man, and had been on a big job on the African Gold Coast. But, when he got the wire from his boss he grabbed the next boat to Brazil.

"Schultz was thorough. He started out by taking readings across the insulated bearings. They varied from 1300 to 400 ohms, which was a mighty low value. Victor said he knew that a properly insulated bearing should give a megger reading of several thousand ohms. And he was right.

"After monkeying with the insulation, the generator was started. It showed some improvement. Then suddenly the temperature started climbing again. But Schultz noticed that the open circuit voltage of 7 volts across the insulated bearing had dropped to 2 volts. That could mean the drop was due to a change in resistance and that more current was flowing through the shaft.

"He shut down the machine pronto, measured the resistance, and



A 300 hp, 360 rpm, 2300 volt, 1.0 power factor E-M Direct-Connected Synchronous Motor driving a 3-stage compressor providing air for a soot blower in a large chemical plant.

What every new compressor should have

● Nicest thing you can do for a new large compressor is to couple an engine-type synchronous motor to it. There's no better way to assure a most economical, reliable and trouble-free drive. Look at the advantages:

1. HIGH EFFICIENCY conversion of electric power to mechanical power by synchronous motors . . . resulting in minimum electric power cost operation of the compressor.

2. POWER FACTOR CORRECTION by unity or 0.8 leading power factor synchronous motors . . . supplying leading reactive kva to improve plant power factor and further reduce power costs, save money on your power bills.

3. DIRECT-CONNECTED synchronous motors save valuable floor space and require minimum maintenance.

4. SIMPLE STARTING at full voltage is suitable for most direct-connected synchronous motor compressor applications. Or you can use E-M-invented part-winding starting where starting limitations are severe. E-M starting arrangements are low in first cost and maintenance cost.

And there's nothing nicer for your compressor than an *E-M* Direct-Connected Synchronous Motor. E-M, pioneers in the development of synchronous motors and control, have over 40 years' experience in the design of synchronous motors incorporating desirable characteristics and features such as those above.

Let the E-M specialist engineer team design a smooth-running, modern drive unit to meet the requirements of your new compressor application. For complete information on E-M Synchronous Motors and their application in your plant, consult your nearest E-M sales engineer. And write for the issue of the E-M Synchronizer titled "The ABC of Synchronous Motors".

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

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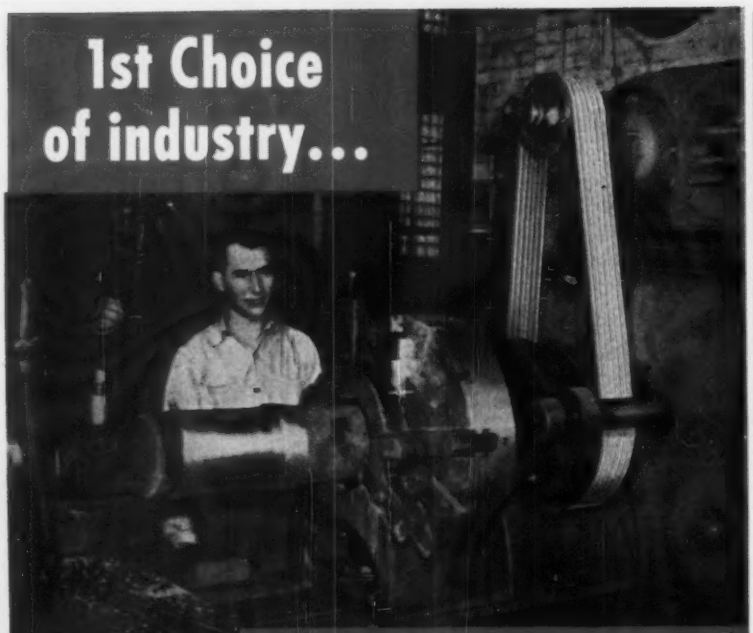
E-M

SPECIALISTS IN
BIG MOTOR ENGINEERING

1st Choice of industry...

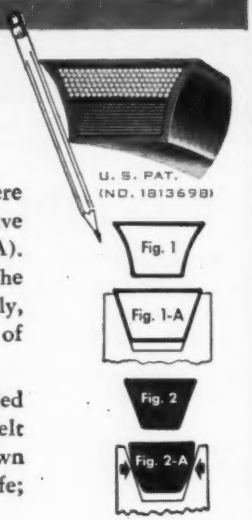


the V-belt with concave sides

Here's why:
The Concave Sides of Gates V-Belt *insure* longer life... lower costs

Try this. Bend a Gates V-Belt as if it were going around a sheave. Feel how the concave sides (Fig. 1) *fill out*... become straight (Fig. 1A). This precise fit insures full contact with the sides of the sheave... grips the sheave evenly, distributing wear uniformly across the sides of the belt. Uniform wear lengthens belt life.

Make the same test with a straight-sided belt (Fig. 2). Feel how the sides of the bent belt *bulge out*, concentrating wear at points shown in Fig. 2A. Uneven wear shortens belt life; increases costs.



Because Gates V-Belts with Concave Sides are so universally preferred, they are also the *most widely available.* Gates V-Belts are carried by leading distributors in industrial centers throughout the world.

The Gates Rubber Company, Denver, Colorado

Gates *World's Largest Maker of V-Belts* TPA 342

Gates VULCO ROPE Drives

Marmaduke

Continued from page 162

found it had dropped to 360 ohms. Although that wasn't enough to cause the trouble, the fact that it kept changing had him buffaloed. This had happened only yesterday. So when Bert heard that I was aboard the *Osprey*, and heading for Santos, he figured I might be of help.

"We were to be loading coffee in port for three days, so I promised Bert and Schultz I'd go back to Sao Paulo with them and tackle their balky generator. It was a challenge I just couldn't pass up.

"Next morning Bert introduced me to his boss, who was a rich Dutchman from Antwerp. He looked like a good Joe and welcomed any help I could give, saying that he'd make my time worth while if I came up with a solution.

"After looking around and sizing things up, I decided that some harmless and insignificant looking component was causing that low resistance reading. But what? Bert and Schultz agreed, said the trouble was probably so simple that they overlooked it. They both would work with me if I'd call the shots. They had already tried everything they could think of.

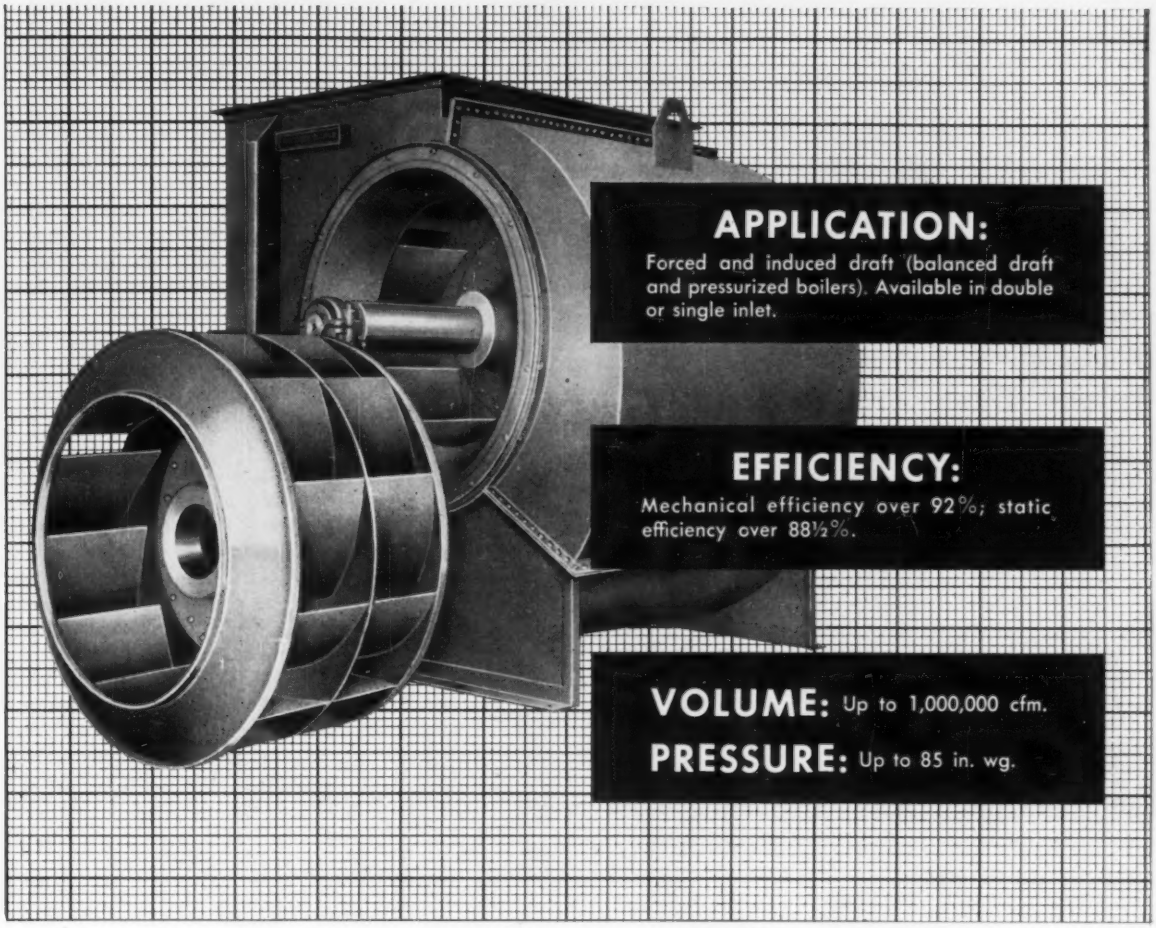
"First I had them check the paint on the insulation under the bearing. I've seen paints with a lead base act as a conductor. But it was OK. Next I had them remove and isolate the thermocouple leads. They proved OK too. We even removed putty from attached wires, but nothing happened.

"Then, while I was watching the Type "S" Leeds & Northrup bridge, one of the boys accidentally touched something that gave the needle one hell of a kick. But no one could tell me exactly who touched what.

"We were getting hot, so we buckled down. But it was like finding a marlin spike in a cargo hold when you weren't sure that it was a marlin spike you were looking for.

"Just then, the needle took another hefty kick. At the same time, I noticed Schultz had leaned on the bearing oil line. A quick inspection showed the line was insulated by being coupled with a 6-in. piece of rubber hose. The two metal pipe ends were a ¼-in. apart, so the current had to go through the rubber coupling. But I knew that current

AMERICAN BLOWER AIRFOIL FANS


APPLICATION:
Forced and induced draft (balanced draft and pressurized boilers). Available in double or single inlet.
EFFICIENCY:
Mechanical efficiency over 92%; static efficiency over 88½%.
VOLUME: Up to 1,000,000 cfm.
PRESSURE: Up to 85 in. wg.

If you're thinking "airfoil" on your next mechanical-draft installation, think of American Blower.

For, the advanced design of American Blower Airfoil Fans provides a smooth interworking of properly designed housing, streamline inlets, and wheel component parts — which results in higher efficiency, lower power consumption. The nonoverloading horsepower characteristic makes it possible to select a driving motor close to the fan horsepower.

Team this fan with American Blower *Gyrol*® Fluid Drive and you have a unit which gives high efficiency with low operating cost — plus quieter operation over the full operating range, and longer life of the critical fan parts. In addition, a motor with standard WR^2 capacity is all that is required, because of low starting inertia.

Why not talk to an American Blower sales engineer about *your* requirements. His knowledge of air-handling equipment can prove invaluable to you. Call our nearest branch office, or write: American-Standard,* American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

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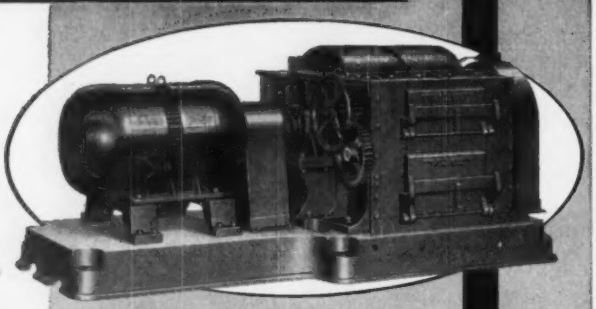
American-Standard Products

AMERICAN-Standard

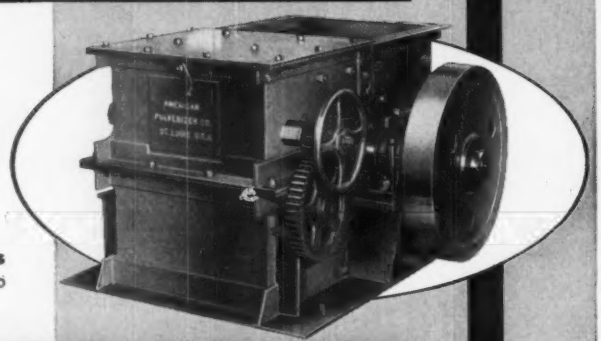
AMERICAN BLOWER DIVISION

When You Figure . . .



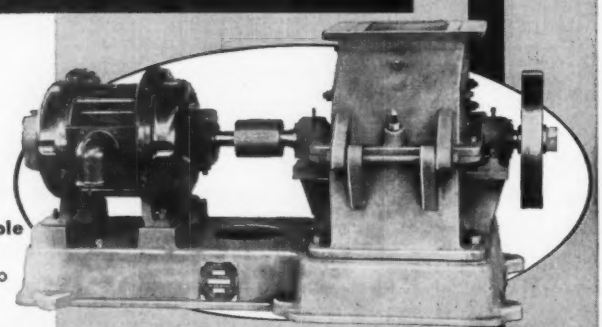
AC Series capacities to 800 TPH

Reduction Cost Per Ton . . .



WC Series capacities to 90 TPH

the Best Answers*. . .



Coal Sample Crushers capacities to 2000 Lbs. Per Hr.

Come from *American* Ring Coal Crushers

*In a recent independent survey, it was found that American Crushers reduced over 61,000,000 tons of coal at a parts replacement cost (including standby parts) of *less than 1/10th of 1¢ per ton.*

THERE CAN BE NO BETTER PROOF OF AMERICAN QUALITY!

American PULVERIZER COMPANY

WRITE for Literature on These Crushers

Originators and Manufacturers of Ring Crushers and Pulverizers

1349 MACKLIND AVE. • ST. LOUIS 10, MO.

Marmaduke

Continued from page 164

had no business traveling through rubber. And yet it looked like it did. Or did it?

"'What goes on here?' I asked the German. 'You just can't pass current through rubber with an "S" set—or you shouldn't be able to. Give me a hand and help me yank out this rubber.'

"As soon as we did, the resistance shot up to over 6000 ohms. We then removed the rubber coupling from the other bearing oil lines. The reading climbed to 12,000 ohms. That's when I cut the hose and measured the resistance along its length. Reading was zero ohms at one inch with a 500-volt megger. So the rubber insulation was the gremlin.

"Schultz piped up and said that the hose was probably one of those new synthetic varieties. He thought it had been installed without checking its electrical qualities. But he explained to the boss that the hose wasn't supplied by his firm, but by the local contractor. That made him feel better for not finding the trouble.

"Bert was happy because after living with that generator for months he could now relax and tackle his everyday problems. And the boss was all smiles because his plant could start cashing in on their capital investment after a year's outage.

"That night the boss took Schultz, Bert and myself out on the town, after fattening my bankroll with some Brazilian green stuff."

Marmy suddenly stopped sounding off and gave his audience a stern look. Then he roared, "There's one important lesson I've learned about plant design from that experience. And that's to check every new material before installing it as an electrical insulation regardless of what the instructions say. If not, you often waste more money on tracking down some innocent looking two-bit item in the system than the equipment is worth.

—STEVE ELONKA

Marmy's Mailbox

COLORFUL

Been reading the Marmy stories while on vacation. They've given me many chuckles. That color, that ingenuity—in no time I was completely won over by Marmy's unquiet charm.

G RICHNER, *Rochester, N. Y.*

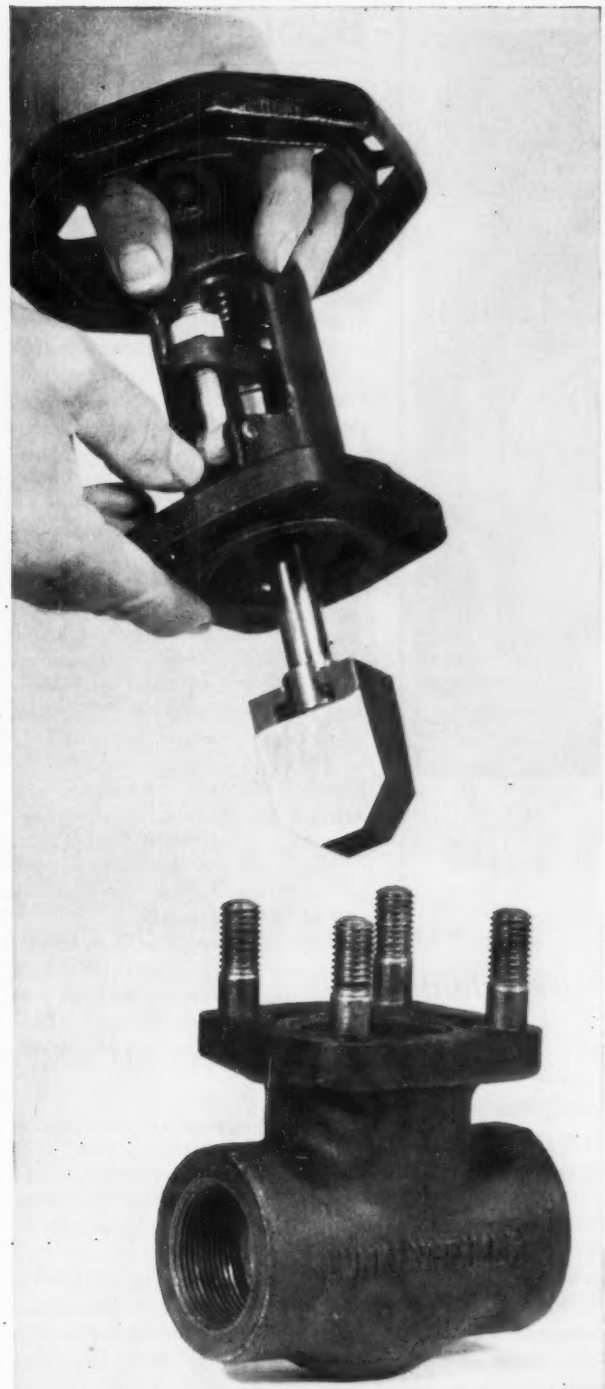


Fig. 8001 Screwed Ends. Sizes ½" to 2"
Fig. 8002 Socket Welding Ends

A New Lunkenheimer Valve

CHECK THE FEATURES OF THIS LUNKENHEIMER FORGED STEEL GATE VALVE

This new Lunkenheimer Forged Steel Gate Valve is already building a reputation for rugged service. Completely new in design, it's compactly built for fast installation in the most cramped quarters. Produced with famous Lunkenheimer materials and highly-skilled workmanship, it handles pressures of 800 lbs. at 850°F., and 2000 lbs. at 100°F. easily and safely. Discs are 13 Chrome Stainless Steel, heat treated completely through to 500 Brinell hardness to eliminate chipping or cracking. Rolled-in Seat Rings can't work loose. This newest addition to the world-famous Lunkenheimer line can help solve *your* valve maintenance problems. Call your Lunkenheimer Distributor, or write us for literature. The Lunkenheimer Company, Cincinnati 14, Ohio.

BRONZE • IRON • STEEL • PVC

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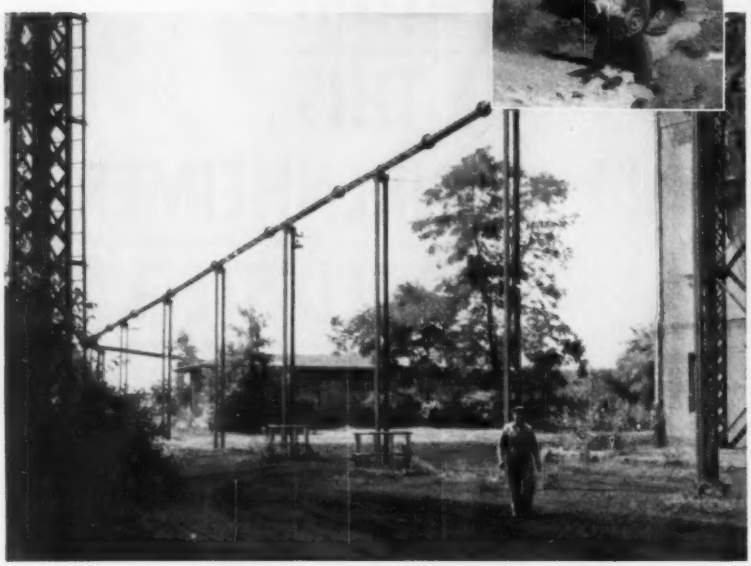
LUNKENHEIMER QUALITY

LUNKENHEIMER®
THE ONE *Great* NAME IN VALVES

MAINTENANCE CUT 90%



ACE Rubber-Lined Ash Pipe

. . . saves 20 days a year turning and patching pipe at New Haven Railroad's Cos Cob Power Plant

Cinders and fly-ash pouring down this 300-ft. long pipe from the ash handling system of the New Haven Railroad's main power plant quickly scoured holes in cast iron pipe. To save trouble, the heavy pipe was rotated ⅛th of a turn every three months, a few sections at a time. The job took five days.

Then Ace rubber-lined pipe was installed. Its remarkable abrasion resistance kept it in service for three years before turning! Even then, its light weight made it possible to turn 200 ft. at once, finishing the job in one day instead of five.

Ace pipe, lined with rubber developed especially for ash systems, offers *you* these savings too. It's one of *nine* types of Ace plastic and rubber pipe made for tough jobs.

AT LAST! A PERMANENT CURE FOR CONDENSATE RETURN LINE CORROSION

Extensive tests show Ace Tempron pipe... rigid, heat-resistant nitrile hard rubber ...is immune to hot, corrosive steam condensate. Ask about it.

AMERICAN HARD RUBBER COMPANY
Division of Amerace Corporation
ACE ROAD · BUTLER, NEW JERSEY

ACE

Bookshelf

Work Sampling. *By Robert Heiland, Assistant Professor of Industrial Engineering, Lehigh University; and Wallace J Richardson, E I du-Pont de Nemours, Inc. 243 pp, illust, 6 x 9. $6.00. McGraw-Hill Book Co, 330 W 42nd St, New York 36, N. Y.*

Comprehensive how-to treatment of work sampling, a highly flexible, economical method for work measurement. Book is self-sufficient so that those unfamiliar with technique can now conduct a study. It explains theory, furnishes necessary statistical information, and gives clear, step-by-step instructions for planning, carrying out, and interpreting a study. Also shows how to take action on basis of results.

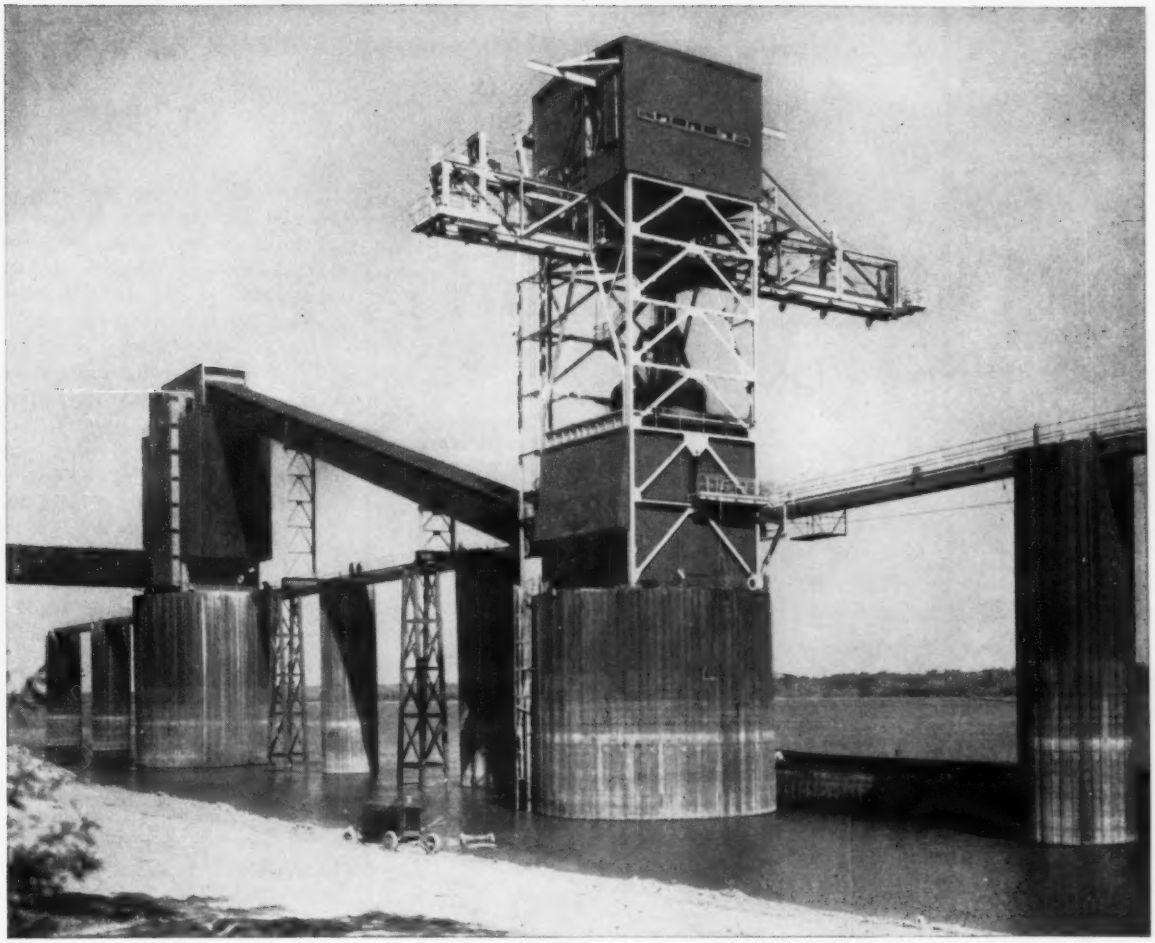
Besides few applications previously recognized for work sampling, authors show that it's equally valuable as a method of work measurement to a large number of other fields, even non-repetitive work. Shows how to cut clerical, maintenance, materials handling and service personnel costs. Book can be used to economically measure office work, machine accounting, construction operations, drafting departments; and hospital and department store activities as well as factory operations.

Work sampling gives a new, valuable skill to professional personnel, time-study and control workers, procedures and methods men, data-processing supervisors and factory superintendents.

Heating, Ventilating, Air Conditioning Guide, 1958. *6x9, 1805 pp, clothbound, $12.00. American Society of Heating and Air-Conditioning Engineers, Inc, 62 Worth St, New York 13, N. Y.*

This 36th edition of the yearly guide shows several revisions. Fundamentals section is the same; air-contaminant classification has been brought up to date.

Cooling-load info has been expanded, and several chapters in the section covering heating-cooling systems and allied equipment have been revised. Chapters on industrial exhaust and drying systems have been rewritten, improving both. Codes and standards section is larger, with current editions indicated and new standards added. Chapter references are a good source of detailed data.



9-ton coal unloader, with free digging capacity of 850 tons per hour, has an average operating lift of 75 feet and travel distance of 40 feet.

Barge unloading?...WE DO THE COMPLETE JOB—unloading tower, dock and all auxiliaries

Dravo experience in the design and construction of complete bulk materials handling installations can help you lower coal handling costs materially. Take the facility shown above. The cellular steel sheet pile dock requires no maintenance, provides safe mooring for barges and supports the barge shifters, other auxiliaries and the unloading tower.

This all-welded tower has a single hoist motor and drum which perform all hoisting and lowering operations. Hoisting rope pull is equalized, and a counterweight reduces hoisting horsepower. A separate drive provides independent and positive bucket closing.

Dravo facilities provide for the design, fabrication and erection of the complete job. Tower, dock and auxiliaries are integrated into a smooth-running installation designed to operate at maximum efficiency and low cost.

Dravo heavy materials handling equipment is at work in power plants, steel mills, port docks and other materials transfer points. You can learn about Dravo's complete line of trolleys, bridges, towers and other related equipment by writing for Bulletin #225. Better still, let us arrange for your visit to actual installations. Simply call us at Pittsburgh, Spalding 1-1200, or write DRAVO CORPORATION, PITTSBURGH 25, PENNSYLVANIA.

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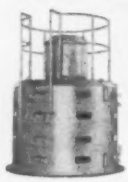
WOUND ROTOR MOTORS

VERTICAL MOTORS

HIGH SPEED A.C. GENERATORS

LARGE D.C. GENERATORS



LARGE VERTICAL MOTORS AND GENERATORS

LOW SPEED SYNCHRONOUS MOTORS

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MOTOR-GENERATOR SETS

SWITCHGEAR AND CONTROLS

Quality

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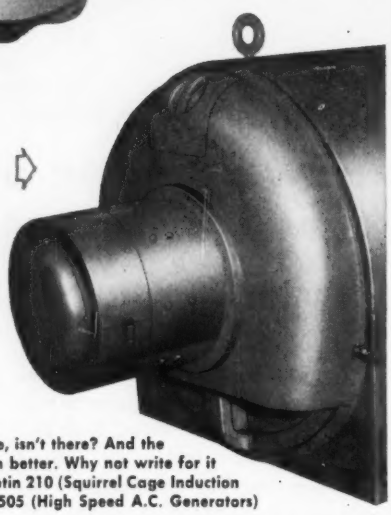
All motors and generators look pretty much alike on the OUTSIDE, you say? LOOK AGAIN!

Check the one-piece sheet steel cover running the full length of the frame and extending well below the centerline on each side. That means strength and protection for internal parts.

Now, notice the cast-aluminum end shrouds with recessed access plates. Protection again—plus a big assist in maintenance and servicing. Lift the plate for oiling and inspection. Lift off the shroud for repair and overhaul.



There is a difference, isn't there? And the INSIDE story is even better. Why not write for it today? Ask for Bulletin 210 (Squirrel Cage Induction Motors) or Bulletin 505 (High Speed A.C. Generators)

HIGH SPEED MOTORS AND GENERATORS

The IDEAL ELECTRIC & MANUFACTURING CO.
360 East First St. Mansfield, Ohio

SINCE 1903, AMERICA'S FINEST MOTORS, GENERATORS, MOTOR-GENERATOR SETS, SWITCHBOARDS AND CONTROLS

My biggest boner . . .

happened to someone else. At an ordnance plant during the war, manpower was scarce. The new steam plant was ready for final adjustments before being put on line. Much of the plant personnel were hillbillies—but that's all the supervisor could get.

One day an operating engineer had to adjust a weight-and-lever type steam-pressure reducing valve. The gage was mounted about two operating levels above the valve. So instead of trusting a hillbilly to make the adjustment the operator sent one of the hillbillies up to watch the gage while he did the adjusting himself.

The gage was a dial type, reading a maximum of 50 psi. He wanted to raise the steam pressure from 10 psi to about 30 psi. The operator asked his helper to tell him what the gage pointer was doing as he shifted the weight on the reducing valve, and to yell out when it hit 30 psi. This last statement evidently got away from the hillbilly as he scooted up the ladder.

At the first outward shift of weight he yelled, "She's up a little." The engineer shifted the weight out a bit farther, and heard, "She's up a little more." After the next step the report was, "Still going up."

One more shift and the report was, "Now she's going down."

This didn't seem right, but to make sure the operator moved the weight out several notches. Next report was, "She's going down fast . . . She's all the way down."

With that, the operator frantically scurried up the ladder. He found the gage needle pressed tightly against the stop at 50 psi.

The hillbilly had been reporting the pointer as "going up" as it rose from the 10-psi mark, until it hit 25 psi, which was at the top of the arc. After that, as far as he was concerned, it was "going down."

H G EBERT, *Philadelphia, Pa.*

Trend toward broader application of instrumentation should continue. Only 10 to 15% of industry potential is now realized, says Minneapolis-Honeywell Regulator Co's H F Dever.

Steel stack and breeching being gun-lined with refractory concrete (made with LUMNITE calcium-aluminate cement) at United Illuminating Company, New Haven, Conn. Gunite Contractor: Pressure Concrete Co., Newark, N. J.

ATLAS LUMNITE in stack linings . . . protects steel shell from corrosion and heat

- Refractory concrete linings (made with ATLAS* LUMNITE cement) resist the corrosive action of flue-gas condensate which forms on stack surfaces.
- Concrete retains high strength under continued exposure to heat and frequent heating-cooling cycles.
- Placement is fast, easy, economical – by guniting, pouring or plastering.
- Downtime is reduced because concrete reaches service strength in 24 hours.

For maximum convenience, use castables made with LUMNITE* cement. These are packaged mixtures, ready for use. Simply add water, mix and place. Made and distributed by leading manufacturers of refractories.

Write for "Lumnite Mortar Manual," describing gun-applied linings: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

L-175

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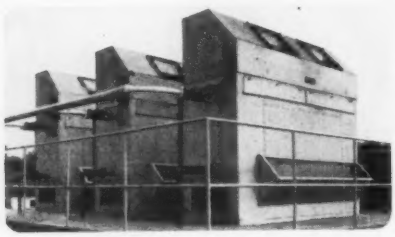

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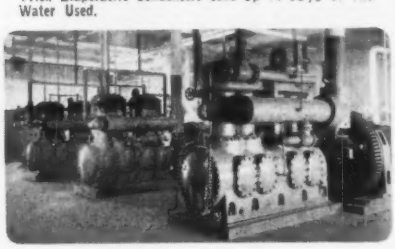

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DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA., U. S. A.

Kill "boiler hp"

Continued from page 93

absorb . . . heat absorption is a function of velocity, temperature, fuel-firing methods, baffling, circulation, and many other variables.

From the manufacturer's standpoint, therefore, I wholeheartedly agree with the philosophy that "boiler hp" is an outmoded thing and the expression "lb per hr" of steam at a stipulated pressure and temperature is far more accurate and meaningful. . . . The average user of steam equipment is more concerned with "lb per hr" than with "hp" or percent rating for a given size boiler. If he is using steam for power generation, or for turbine applications, the term "lb per hr" gives him a direct indication of the amount of power he can produce. On the other hand, if he is using the steam for heating purposes, "lb per hr" can easily be converted into any units currently in use in the heating industry. . . .

GORDON O GARIS
Bros Incorporated

. . . long needed . . . The editorial covers a custom which has long needed correction, and making repeated statements along these lines is the only way to do this.

It might be worth mentioning also, that a more fundamental method of rating is that of "Btu per hr". This has the advantage of taking care of pressure and temperature variables as well as being applicable to hot-water boilers.

A M BAIN
Dominion Bridge Company, Ltd

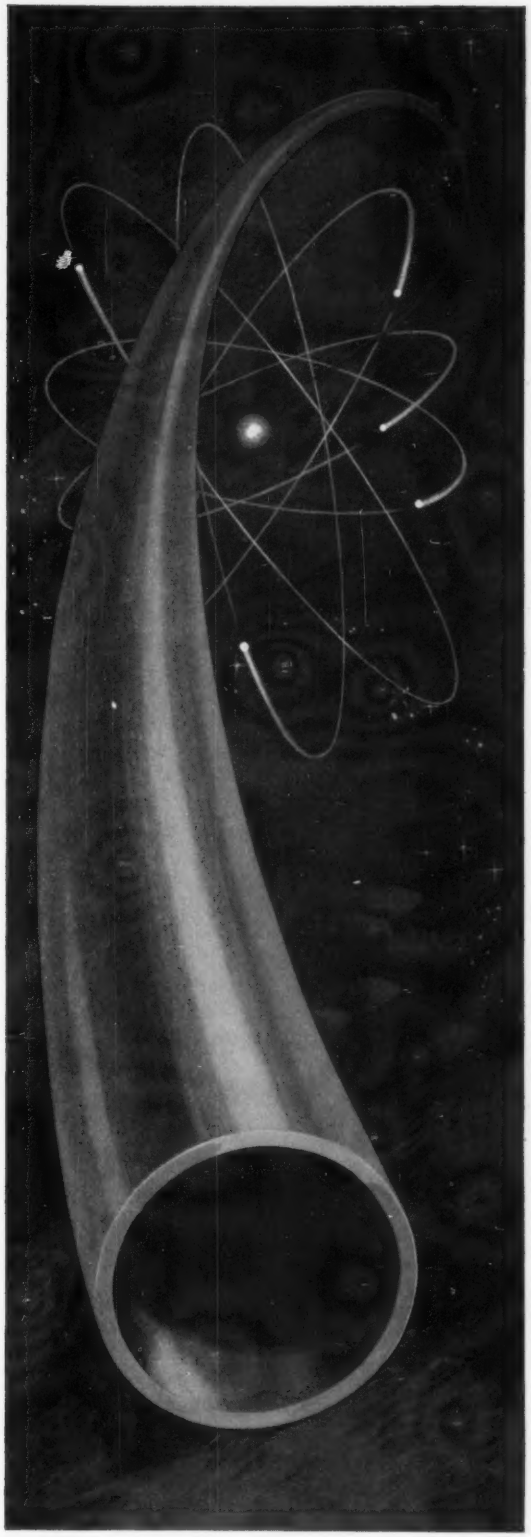
. . . why not Btu? . . . I wholeheartedly agree that the term "boiler hp" is one we could all do very well without, but if a change is indicated, why not make it on the basis of the fundamental unit of heat, the much-neglected, lowly Btu?

It would seem that the Btu is the most fundamental unit of heat measurement, and is the unit which is most used in process heating. For heating loads there is already a firmly established conversion factor from sq ft of radiation to Btu.

Let's kill "boiler hp" and substitute "Btu" as a fundamental unit . . . for rating boiler performance.

W F SPREHE
The Mettler Co, Inc

Turn page ►



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To keep pace with the steadily growing importance of the nuclear power field, Phelps Dodge will soon open one of the largest tube mills in the world at South Brunswick, N. J. This mill will have the most modern automatic tube fabricating machinery, the finest research laboratories and the most advanced testing equipment.

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America's Oldest Manufacturer of Mechanical Packings

Kill "boiler hp"

Continued from page 172

. . . correct engineering approach

. . . Boiler output in terms of "Btu per hr," "lb per hr," or "boiler hp" . . . should tell the customer the *maximum* he is going to get out of the boiler. Because of the misuse of these terms . . . engineers and customers have been given false impressions regarding boiler output.

Here is a typical example . . . a catalog states that a boiler will produce 74 hp, or 2560 lb per hr of steam from and at 212 F. In the same chart, he [the maker] lists a second rating which he calls "certified." This rating says that the same unit will produce 111 hp, or 3840 lb per hr. If you were selcting a boiler, which figure would you use?

The packaged-boiler manufacturer . . . has always presented boiler ratings on the basis of guaranteed maximum continuous output. This has only been possible because of constant study of fuels and their combustion, burners, pressure-vessel design, and because of regular, routine fire-testing of each product produced. Thus, proven performance with a fully assembled, factory-tested unit can and should reflect itself in the form of guaranteed maximum continuous output ratings.

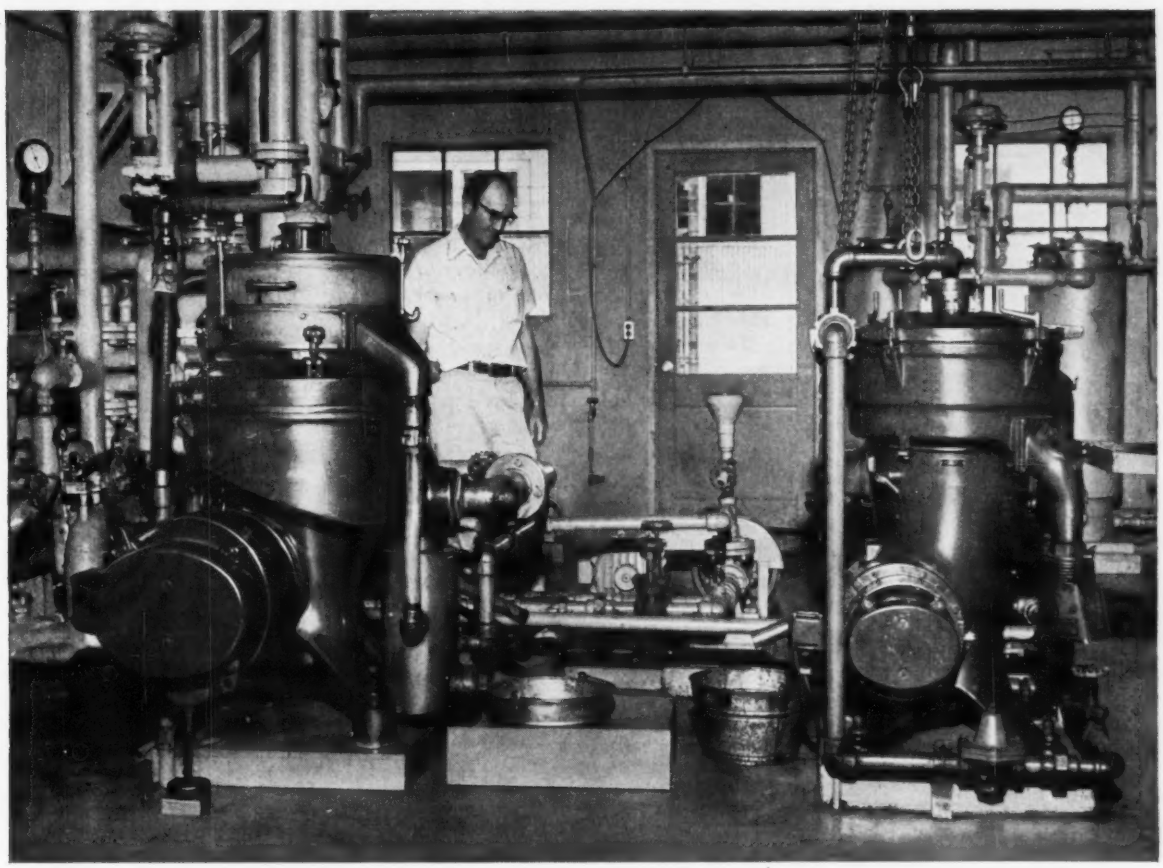
When calculating required boiler size, an engineer or customer will normally figure his steam load as follows:

Machinery requirements for process steam	____Btu/hr
Heating load for plant	____Btu/hr
Piping, pickup losses	____Btu/hr
Possible future expansion and/or safety factor applied by engineer	____Btu/hr
Total heat required	*XYZ* Btu/hr

Then *XYZ* Btu per hr, divided by 970 Btu per lb of steam, equals *W* lb of steam per hr from and at 212 F. This requirement can easily be matched against the maximum output specified in a packaged-boiler catalog.

At this point, the person selecting the boiler should study other important features of each boiler manufacturer under consideration. Some of these features are: (1) Sq ft of heating surface in the boiler (2) simple, but effective, burner design (3) experience and reputation of the boiler manufacturer (4) boilers operating under similar conditions in the same

"We saved $45,000 in the last twelve months using residual fuel purified by the De Laval AC-VO 'Nozzle-Matic' Heavy Fuel Oil Purifier. The machine operates 22 out of every 24 hours... maintenance has been negligible."



Robert L. Whitesides, Superintendent
Municipal Light & Power Plant
New Smyrna Beach, Florida

For further information about conversion to profitable heavy fuel operation, contact your local De Laval representative. Or write to us for Bulletins S. A959 and S. A957. No obligation, of course.

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14TH INTERNATIONAL HEATING & AIR-CONDITIONING EXPOSITION
480 Lexington Avenue
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Management: International Exposition Co.

Kill "boiler hp"

Continued from page 174

area (5) ease of maintenance of the boiler (6) availability of good service and parts (7) appearance of a modern boiler using the latest design features. With this information, he can then select a steam-generating unit which will meet his load requirements and substantiate his selection based on performance of the product and the company behind it.

Maximum boiler output, expressed in terms of "Btu per hr" or "lb per hr" of steam from and at 212 F, is certainly more indicative of a boiler's capacity than "boiler hp". This is the correct engineering approach to the rating of boiler equipment!

H F Holtz
Cleaver Brooks Company

Keep "boiler hp"

Continued from page 93

"horsapower" and to tell them that they should ask for a 300-lb-per-hr boiler rather than a 10-hp boiler would be a forlorn cause.

In other words, plainly stated, it would seriously interfere with merchandising and I don't think we want to do that at this particular stage of our economic history.

And I don't really think there is too much wrong with horsepower as a designation of boiler capacity. And "boiler hp" is just as definite and unvarying a descriptive term as is horsepower. We think of a boiler hp as representing the transfer of 33,475 Btu of heat into the boiler and certainly that is a definite enough quantity. In fact, I think that to use "lb per hr" as a standard would be less definite because a given boiler will develop more lb of steam at 15 psi than it will at 100 psi. True, a boiler could be rated at so many lb per hr at such and such a pressure, but that would be no more definitive than to use the word "horsepower" . . . We in our literature list both "boiler hp" and "lb per hr" . . . measured from and at 212 F. This way we satisfy both schools . . .

By now you will have gathered that I am not in favor of discarding . . . the term "boiler hp", but I still repeat I ain't mad at nobody.

E E Magnuson
Eclipse Fuel Engineering Co

Turn page ▶

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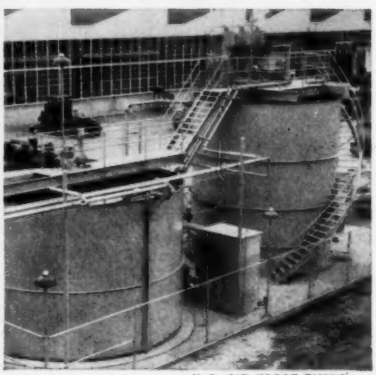

U. S. AIR FORCE PHOTO

HIGH-FLOW, UP-FLOW

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The Clarifier shown above is part of an ILLCO-WAY ionXchange installation, at a metal-finishing plant, which is used for waste disposal and water recovery. Similar Clarifiers are widely employed to clear up surface waters used by various industries — removing organic matter, hardness, alkalinity, turbidity, color, and iron, as required by specific conditions.

USED AS PRE-TREATMENT

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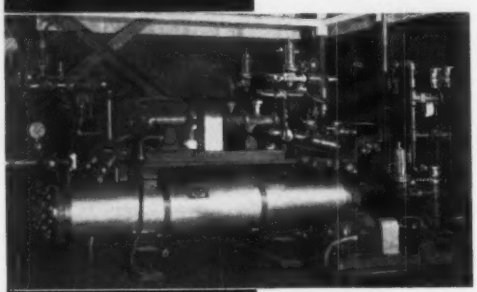

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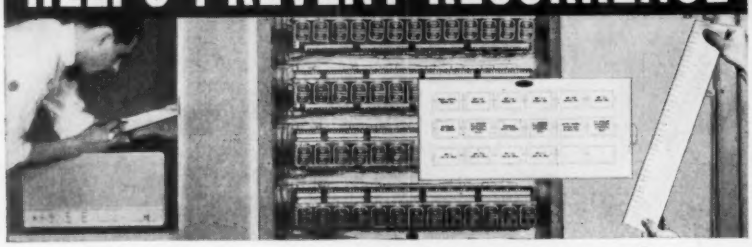

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PANALARM

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7401 No. Hamlin Ave., Skokie, Ill.

Keep "boiler hp"

Continued from page 176

. . . cannot be discarded. . . . The points you make in your editorial are well taken and certainly there are some logical reasons favoring the use of "lb per hr" of steam at given pressure and temperature. However, I do not believe we can eliminate "boiler hp," even on the grounds that its use is a matter of habit. Many of the names of things are the products of custom and usage.

The market for boilers covers the wide span from small service-type companies to the larger utilities, and in many of the industrials, where steam is an adjunct rather than the prime consideration of the business, the familiarity with nomenclature is much less than among those who are concerned with central-station operations. Although the measurement in "lb per hr" is a standard for those concerned with power plants, this term of reference is not used to a large extent by buyers of small steam-generating capacities.

The members of the Package Steam-Generator Branch of the AB&AI have tended to use "hp" to designate boiler ratings and most sales literature, statistics, and records are based on this simple denominator . . . In our literature, most of us do translate "boiler hp" into "lb per hr," and also "Btu per hr," for the convenience of prospective customers.

When the power-plant designers designate "lb per hr" . . . they are talking in terms of a prescribed pressure and with feedwater at specified temperature. In the firetube boiler industry, we are concerned with customers whose needs may be for steam for process, steam or hot water for heating, or both. In calculating requirements of industrial processes the Btu is the important unit of measurement. In heating, the load may also be summarized in Btu per hr. The final requirement in Btu can be easily converted to "boiler hp" . . .

Specifications by consulting engineers for packaged firetube boilers usually state the capacity in terms of "boiler hp," although they may also express the desired rating in "lb per hr." Suppliers of some production equipment for the process industries designate the steam requirements of their units in terms of "boiler hp."

It is undoubtedly true that a variety of terminology can be confusing to

BERGEN GETS 8 LJUNGSTROMS® ...AND SOME REMARKABLE CUSTOMER SERVICE

Public Service's new Bergen Generating Station will be served by 8 large, horizontal Ljungstroms. Almost as important . . . the Ljungstroms will be serviced *throughout* their life by Air Preheater.

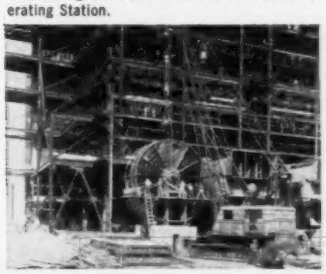
What's special about this customer service? For one thing, it's the considerable knowledge and talents of Air Preheater's engineers. They have been involved in nearly every conceivable type of boiler/preheater problem. They've seen how these problems can be handled. And they can put this experience to work for operators of Ljungstrom air preheaters.

Your Air Preheater engineer also makes regular calls to check the operation of every Ljungstrom – for as long as it's in service. (This now includes installations dating back to 1923.)

So, when you select a Ljungstrom, you're never entirely on your own. You *continue* to be the responsibility of a competent Ljungstrom engineer and benefit from his experience and knowledge. Maybe that's why 9 out of 10 preheaters sold are Ljungstroms.

Thirty-five tons of Ljungstrom rotor being lowered into place at the new Bergen Generating Station at Ridgefield, N. J. (When the heating elements are installed the rotor will weigh 150 tons.) This is one of eight preheaters being installed by Public Service Electric and Gas Co. to serve two boilers – each evaporating 1,900,000 lbs of steam/hr. The first boiler is to be fired early next year. Anticipated preheater outlet temperature is about 275 F.

Public Service is one of the first Northern utilities to use large-size horizontal preheaters. They have nine such horizontals in operation at their Linden Generating Station and have ordered eight more for their new Mercer Generating Station.



THE AIR PREHEATER CORPORATION

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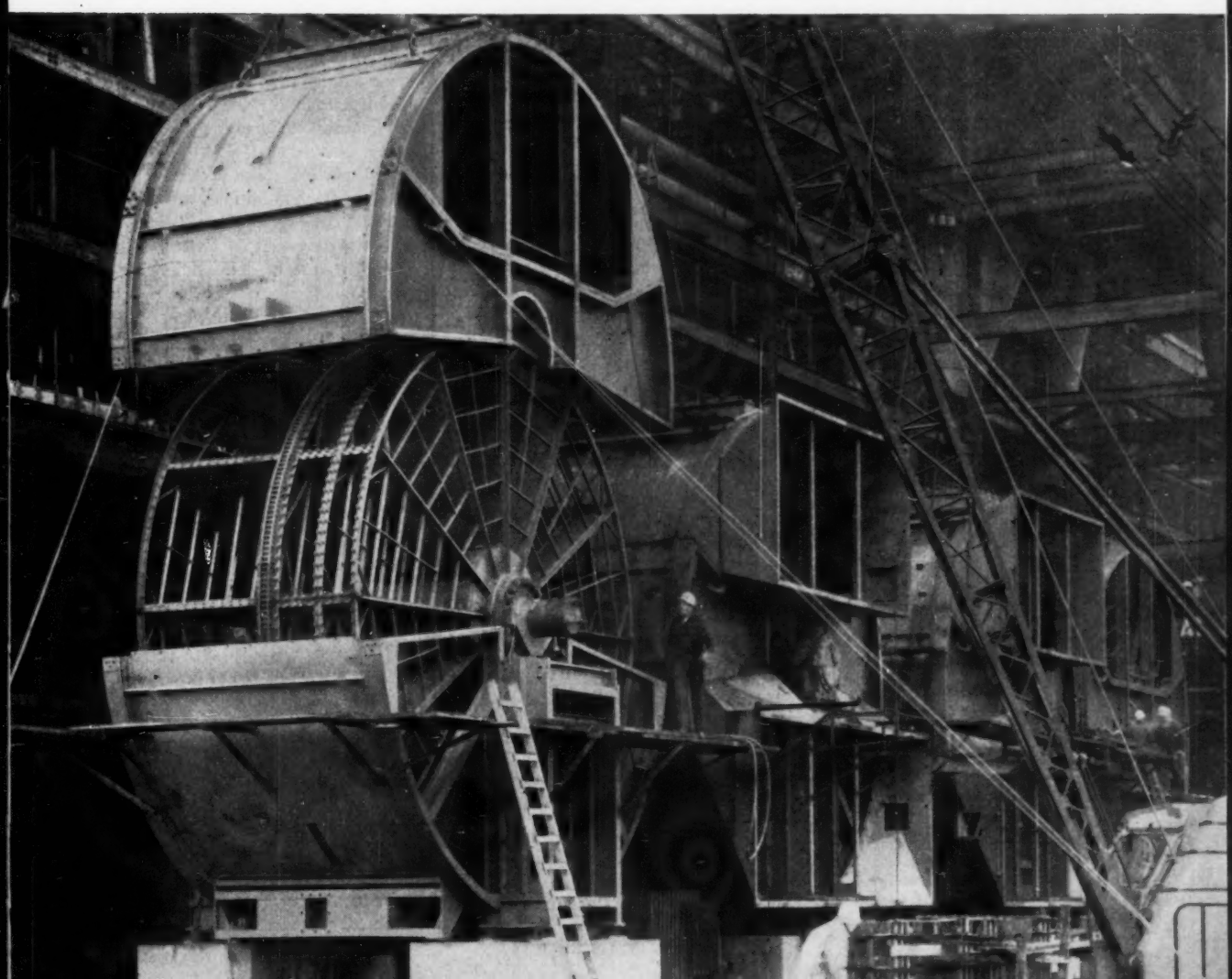

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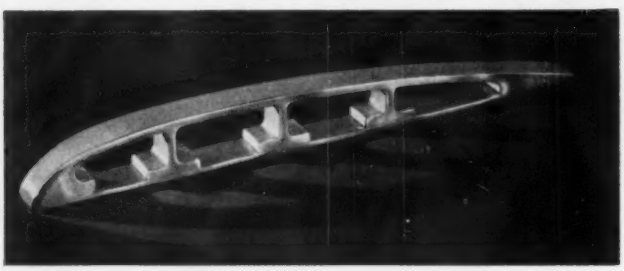

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AEROMASTER'S new, extruded aluminum blades combine in one design the advantages of a light weight metal, a hollow structure and the superior strength of wrought metal... Silicon-magnesium aluminum alloys resist corrosion. Their fine grain structure, high tensile strength and increased endurance limit eliminate danger from wear, vibration, and metal fatigue . . . true airfoil blade sections assure maximum air delivery . . . adjustable blade pitch angle permits decrease of fan load to an accurate minimum horse-power requirement.

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Keep "boiler hp"

Continued from page 178

buyers of steam-generating equipment. However, I feel sure that the term "boiler hp" cannot be discarded abruptly because of its acceptance within an important segment of the market for firetube boilers. In my opinion, it is more likely that ratings based on "edr," and ratings based on heating surface alone, will disappear from the scene at a much earlier date . . . .

WILLIAM B FIRMAN
Orr & Sembower, Inc

. . . why kill it? . . . After reading this editorial, it appears to us that only one point of view was considered.

A "boiler hp" for many years has technically been defined as the evaporation of 34.5 lb of water per hr to dry saturated steam from and at 212-F feedwater, or 33,475 Btu per hr, and all professional engineers are well aware of this definition. The comparison of "boiler hp" versus steam-engine requirements is more obsolete than the idea that 10 sq ft of heating surface makes a horsepower.

"Lb per hr," "Btu per hr," "mbh," and "sq ft of radiation" are all good appellations, but none of them provide the universal coverage of "boiler hp" as technically defined. "Lb per hr" is hardly applicable to a hot-water boiler and hot-water boilers are now being used in larger number, bigger sizes, and are being built for higher operating temperatures than ever before. "Btu per hr" or "mbh" are good descriptive terms for hot-water boilers or steam-heating boilers, but are not appropriate for power or process boilers . . . "Sq ft of radiation", either steam or water, applies only to heating boilers.

The Package Steam-Generator Branch of the AB&AI, realizing the need for clarification, has agreed to list "boiler hp," "lb per hr," and "mbh" (with "sq ft of radiation" optional) for each size of packaged boiler and feels that all of these listings are desirable because an engineer can readily convert "boiler hp" for simplicity in specifying sizes and also because there are thousands of boiler users who know what results they can expect of a "boiler hp" but have no idea of the comparative values of the other labels.

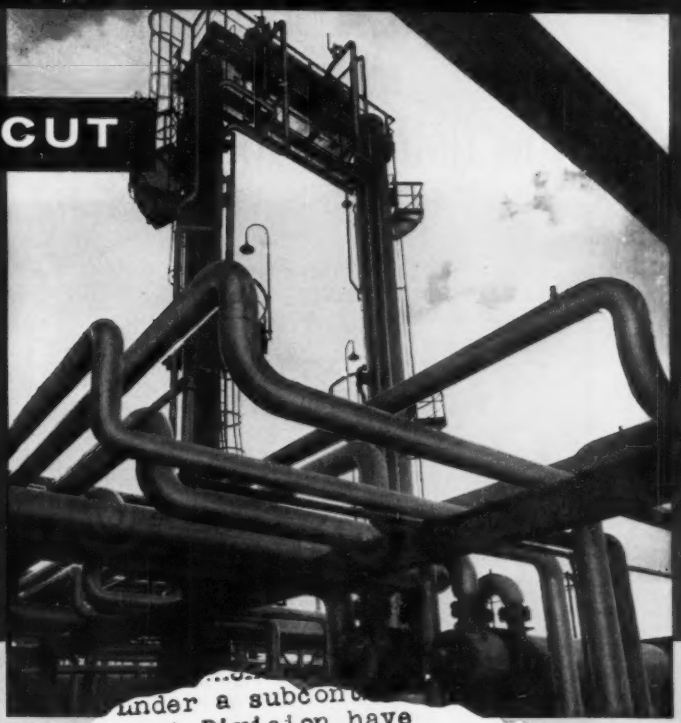
Turn page ►

NOT ONE FIELD CUT

in all This

MIDWEST

Shop-Fabricated Piping



...under a subcon...

and I would like to say the West Coast Division have on this job complied fully with the high standards of workmanship for which Midwest is known.

Throughout this entire project not once was a cut necessary to correct any piece of fabrication, and I might add in several instances close tolerances had to be met.

The above was not written on an impulse but as construction superintendent, this means but one thing: fast and low cost erection. Would appreciate your thanking Midwest personally for ...om a construction

Excerpt from letter by:
HOLMES & NARVER • Engineers-Constructors
828 South Figueroa St. • Los Angeles 17

Note particularly the words "*fast and low cost erection*" in the above letter. They characterize Midwest Shop-Fabricated Piping . . . whether for refinery, power plant or industrial installations. In this instance they were written by A. H. Chamberlain, construction superintendent, upon completing the installation of a Houdriformer Unit at the U.S. Oil & Refining Co., Tacoma, Washington.

There are three well-equipped Midwest pipe fabricating shops located to serve economically all sections of the country. Each is staffed by a highly skilled organization using the latest techniques. Each has wide experience on all kinds of projects so that the possibilities and limitations of all piping materials are well understood. You too will find it to your advantage to call in Midwest whenever you need fabricated piping.

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Guaranteed no-slip Speed Chuck grips tight forward or reverse. Replaceable insert jaws can be changed in seconds. Three-jaw rear centering workholder gives extra support, keeps pipe or rod turning straight for true threads every time. Base has handy tool hanger and pipe benders. Can be bench or truck mounted.

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The Ridge Tool Company, Elyria, Ohio, U.S.A.

Keep "boiler hp"

Continued from page 180

The source of greatest confusion is the seeming lack of, or realization of, the difference between boiler capacity and boiler ratings. Packaged boilers are designated by capacity at the nozzle outlet and this can be definitely stated and guaranteed by the manufacturer, as he has designed, built and tested each unit for capacity and efficiency. Boiler-only manufacturers, having no control over selection, sizing or installation of the firing apparatus and the many variable accessory items, cannot guarantee any definite output. They can, by limitations and qualifications, only indicate what the probable actual output might be, and therefore, to protect themselves and their customers, must list conservative ratings developed by empirical formula, and such ratings are usually further qualified by adjectives: "net", "gross", "nominal".

"Boiler hp", if based on its technical definition, still remains probably the best overall descriptive term for boiler capacity for all types of heat output, and why "kill" it unless a better universally applied term is available?

J F Johnston Jr
Johnston Brothers, Inc

Reciprocating engines

Continued from page 92

speed is not too high. They prove valuable in analyzing engine performance and measuring internal work output. For high-speed engines the mechanical parts of the indicator mechanism have too much inertia and it becomes difficult to get an accurate card.

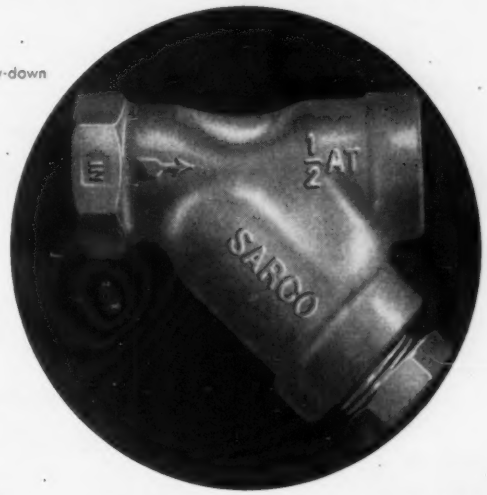
To overcome this limitation an electric oscillograph measures cylinder pressures and relates them to time or crank angle. Fig. 4 shows an actual cycle in solid line and the theoretical in dashed line. Both relate directly to Fig. 1. By suitable measurement, Fig. 4 can be translated into the P-V diagram of Fig. 1. The strokes are indicated at the top of the graph and the time of valve operations and ignition.

Two-stroke cycle engines. In Part 21, Sept 1958, we studied the

(Continued on page 184)

protect your equipment against scale and dirt

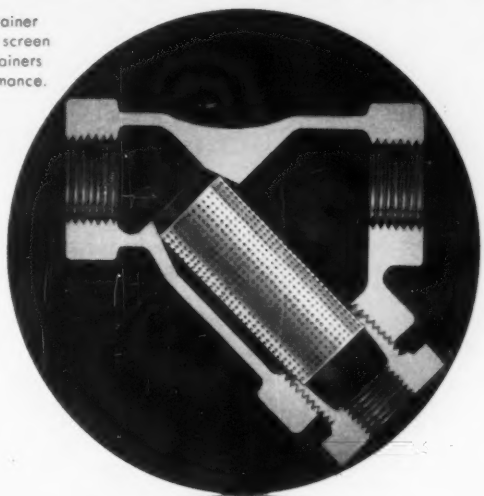
Exterior view of NEW Sarco Type "AT" Pipe Line Strainer. Note 45° blow-down angle to facilitate piping away from strainer



with this

NEW SARCO TYPE "AT" PIPE LINE STRAINER

Cutaway of NEW Sarco Type "AT" Strainer shows sediment collection chamber below screen. Standard screen used in Sarco "AT" Strainers is key to their uniformly successful performance.



Examine one of the new Sarco Type "AT" Strainers and you'll notice at once that its design is a marked improvement over that of contemporary strainers . . . in three important ways:

The Sarco screen, key element of the unit, fits tightly into a long, tapered screen seat. This feature absolutely stops the by-passing of particles around the screen. Secondly, the rigid, welded construction of heavy-gauge brass makes sure the fit will remain tight, even when trapped sediment builds up pressure.

Third, you'll see that the new AT is easy to clean. No sharp edges or weave crevices in the screen for particles to cling to. Blow-down cleaning is simplified by the 45° angle construction.

Write for Sarco Bulletin No. 1210B which gives dimensions, capacities, and technical data. 7317-B

NOTE THIS ADDED PROTECTION AND CONVENIENCE

1. Bodies of heavy-duty 250 psi semi-steel. Tensile strength to 30,000 # per square inch minimum.
2. For maximum strength, bodies are reinforced with external rib.
3. Long, tapered screen seat assures correct screen position and tight fit without buckling.
4. Cap design provides a sediment collection chamber below screen.
5. Generous proportion of open screen area in relation to pipe size minimizes pressure drop.

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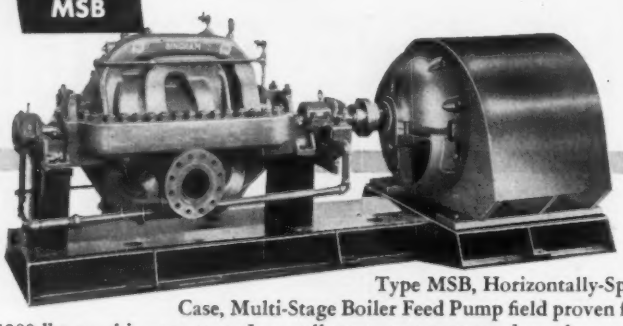
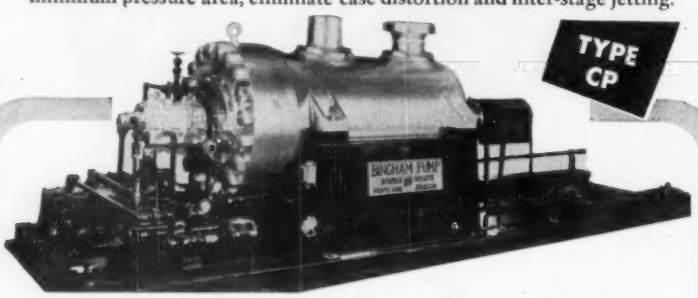


Type MSB, Horizontally-Split Case, Multi-Stage Boiler Feed Pump field proven for 1200 lbs. working pressure. Integrally cast cross-overs and evenly spaced case bolting located uniformly close to the shaft center line, enclosing a minimum pressure area, eliminate case distortion and inter-stage jetting.

TYPE CP



Type CP, Multi-Stage, Double-Case Boiler Feed Pump with forged outer barrel for high pressure service.

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Reciprocating engines

Continued from page 182

free-piston gas generator which uses a 2-stroke-cycle diesel cylinder. Let's study a more conventional 2-stroke diesel engine, Fig. 5. This engine offers opportunities for almost doubling work output in a given cylinder as compared to a 4-stroke cycle.

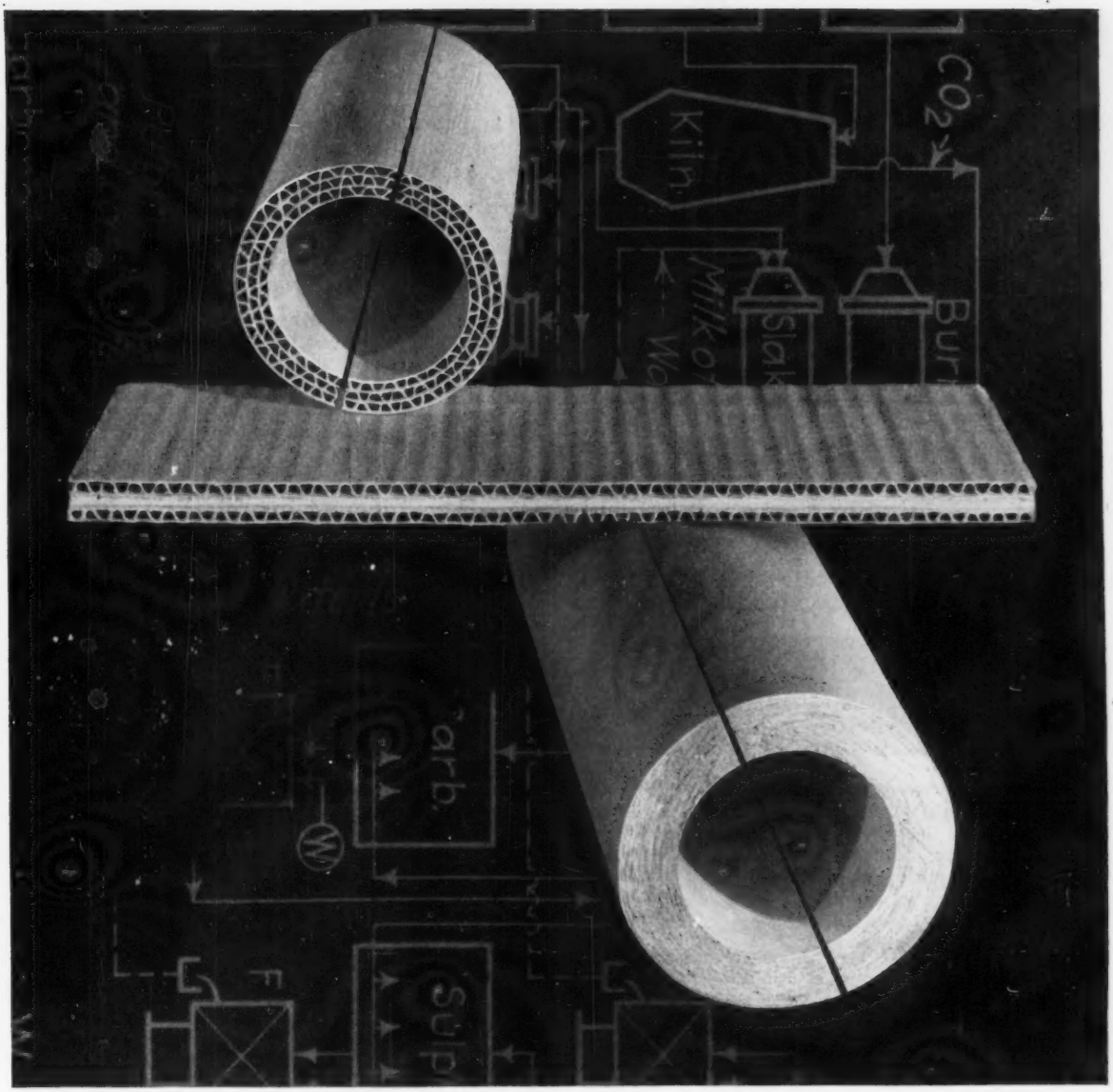
The major problem in this engine centers on getting the exhaust gas out of the cylinder after the expansion stroke and the fresh air in before the immediately following compression stroke. Fig. 5 shows the P-V graph for the engine cylinder. Just before starting the compression stroke at *1* both intake and exhaust ports are open so, during the first part, the piston pushes some air back out the intake and exhaust ports. When the piston skirt closes these ports the pressure rises. Before the end of the compression stroke fuel is forced in and ignites to raise the pressure to *3* after starting the expansion stroke.

Near the end of the expansion stroke at *4* the piston uncovers the exhaust port allowing part of the gas to blow down to atmosphere. From *4* to *1* to *2* fresh air forced into the cylinder through the intake port sweeps out the burned gas through the exhaust port.

Let's see how the air is compressed for this cycle. In (*a*) air which has been compressed in the crankcase leaves through the cylinder intake or transfer port. In the cylinder the shape of the piston face directs the air toward the cylinder top so it scavenges out the gas in the cylinder. As the piston rises in (*b*) the skirt closes off the cylinder transfer port and the air trapped in the crankcase expands below atmospheric pressure. In (*c*) the cylinder skirt has uncovered the crankcase intake or inlet port admitting atmospheric air into the crankcase. In (*d*) the descending cylinder compresses the air in the crankcase as it closes the inlet port. The compressed air can then force its way into the cylinder as in (*a*).

The net work to precompress the air and the part of the piston stroke devoted to scavenging the cylinder makes the 2-stroke cylinder do less than twice the work of a 4-stroke cylinder.

Next part will study energy transfer with steady flow gases—in a forthcoming issue.



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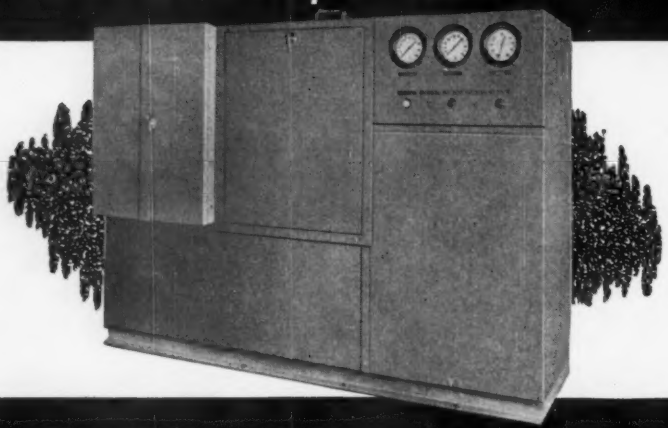

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Units may be used with any standard boiler or furnace under natural or induced draft, or with pressurized boilers—in which case the unit provides sufficient forced draft to overcome draft loss through boiler. Where a high chimney or induced draft fan is used, an automatic damper motor is furnished to provide a constant furnace draft during operations; and a reduced or zero draft during shutdowns.

Preventative Maintenance consists chiefly of keeping the burner gun clean, with periodic inspection and cleaning of strainers and safety devices. This minimum maintenance will give your engineer or fireman extra time to attend to blow-down, soot-blowing, or to check operations and efficiency of plant and auxiliary equipment.

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Rectifiers

Continued from page 85

voltage is adjusted by phase control.

Typical values of the overall efficiency of germanium, silicon, and ignitron power rectifiers with voltage control as a function of the output dc voltage are indicated left center, p 84. For germanium and silicon, the sudden drops in efficiency occur at voltage where it is necessary to increase the number of diodes in series. If voltage control is not required, the efficiency curves of germanium and silicon can be raised by about 1 to 1½%.

Since efficiency is not the only factor considered in selecting a power rectifier, it is also necessary to take into account the economic importance of size, maintenance and first cost before selecting the correct type of rectifier. When this is done, the recommendation as to the type of rectifier which should be used in a typical application is shown at bottom of p 84. The dc voltage is the total voltage for the application and the dc amperes are the total amperes for the installation. The size of the installation makes a difference in the relative weighting of the various factors. Silicon diodes have so many desirable characteristics that the silicon rectifier is the best choice for a wider voltage range. With large current ratings at low dc voltages the low forward drop of germanium diodes may make the germanium rectifier more desirable.

In the voltage region between 10 and 35 volts, characteristics of germanium and silicon are so nearly equal that either type can be applied. The decision can be based on any special requirements. If there are no special requirements and all other factors are about equal, silicon should be applied in this range.

In the range of voltages between 35 and 500 volts the characteristics of silicon rectifiers are so excellent that in a majority of cases no other type of rectifier needs to be considered. The high voltage rating per diode and the large temperature safety factor make the silicon rectifier the best type for use in this voltage range.

Between 500 and 700 volts there is a region of about equal advantages between silicon diodes and mercury-arc units. In this voltage range, the efficiency consideration may be in favor of silicon, but because of the

$Ca^{++} + Na_2Z = CaZ + 2Na^+$

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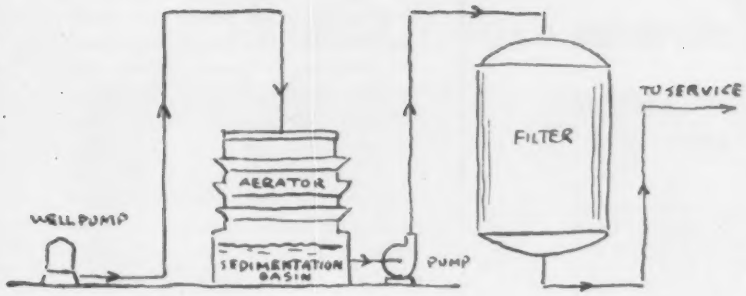
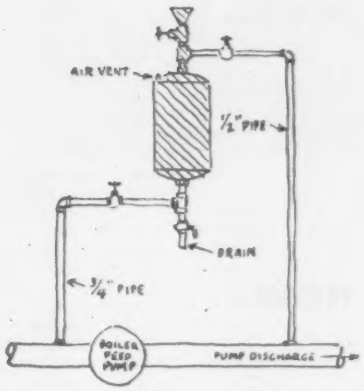
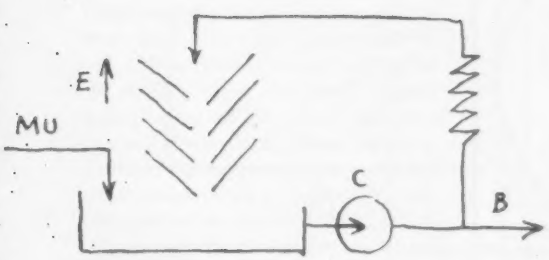




$V = \frac{18.5D^2(S_1 - S_2)}{Z}$

$\frac{x}{m} = KC^{1/n}$

any way you figure it, the best solution to your water problems is . . .



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Rectifiers

Continued from page 186

large number of diodes needed for a large installation the mercury-arc will make a simpler installation. The decision must be based on which characteristics are most important.

Voltage region between silicon and mercury-arc is the most difficult to set exactly since many factors must be considered and all characteristics are rapidly changing with development progress. In the future, the field of application of silicon will be extended up to higher voltages. Voltage rating of silicon diodes is increasing rapidly, and can be expected to more than double itself in the next few years. It will be necessary to establish the long-time performance and diode life as the use of silicon is extended upward into higher voltages. It is estimated that the diode-failure rate will be a few percent per year for large installations, but variations are expected because of differences in the loading on the individual diodes. Since diodes are operated in series, the voltage requirements per diode will be about the same for medium- and high-voltage installations so their average life should be about the same. Low-voltage installations will have better life characteristics. Until considerable data has been analyzed, the diodes should not be overloaded in order to obtain a low equipment initial cost, because this may result in an excessive diode replacement cost. In the long range evaluation a balance will have to be determined between the first costs and failure-rate costs.

Future developments will follow the rapid progress being made in the development of semiconductor devices which will control the start of current flow as well as rectify. (See POWER, Sept 1958, p 109.) These devices will enable the design of power rectifiers with controllable output voltage without saturating reactors. The perfection of large controllable devices will open up an entirely new field since it not only will be possible to obtain a controllable dc current, but also to make inverters which will change dc power to ac power.

Use of semiconductor power rectifiers is expected to grow at a rapid pace, and in the long-range future the application of semiconductor devices to frequency changers will be even greater than to rectifiers.

Availability?...

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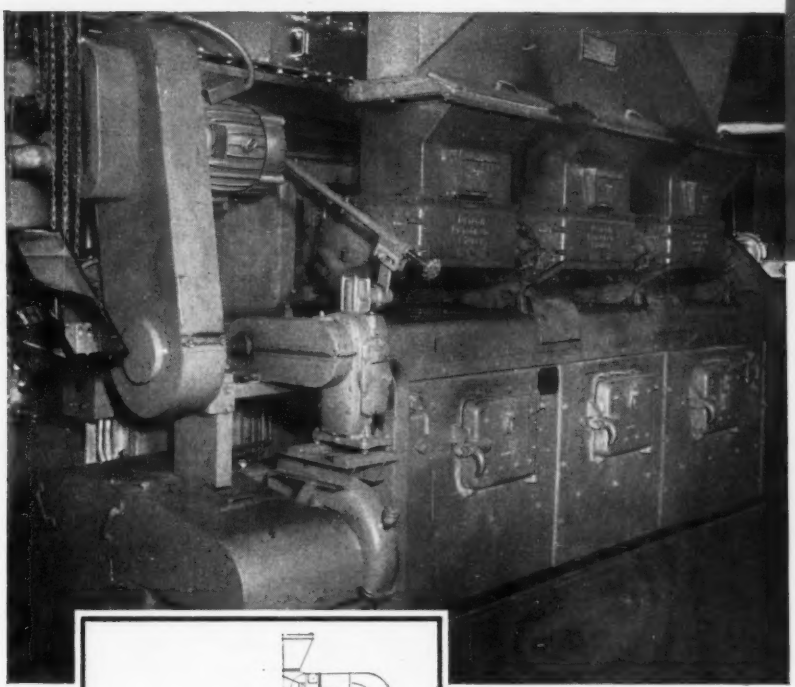
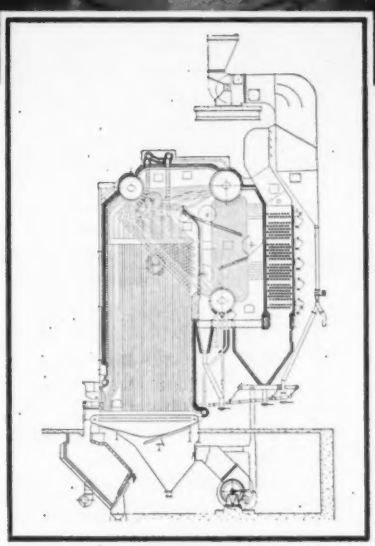


A Detroit RotoGrate Stoker



AT OTSEGO

Detroit RotoGrate Stoker with Wickes Boiler; 650 pounds pressure, 750°F temperature. Cummins & Barnard, Consulting Engineers.

This record of only 5 hours outage in over 5 years is reported by Otsego Falls Paper Mills, Otsego, Michigan, a division of Menasha Wooden Ware Corporation.

Walter Boettcher, Chief Power Engineer says: "*5 hours in 5 years and 4 months is the record of down time due to the RotoGrate Stoker outage*" in this well operated single boiler plant.

"*It operates 24 hours a day—5 to 6 days a week, 60,000 to 90,000 pounds of steam per hour.*

"*Paper mill load fluctuations handled easily without pressure loss.*"

This record indicates a fine job of equipment maintenance, but high availability can be taken for granted with the DETROIT ROTOGRATE.

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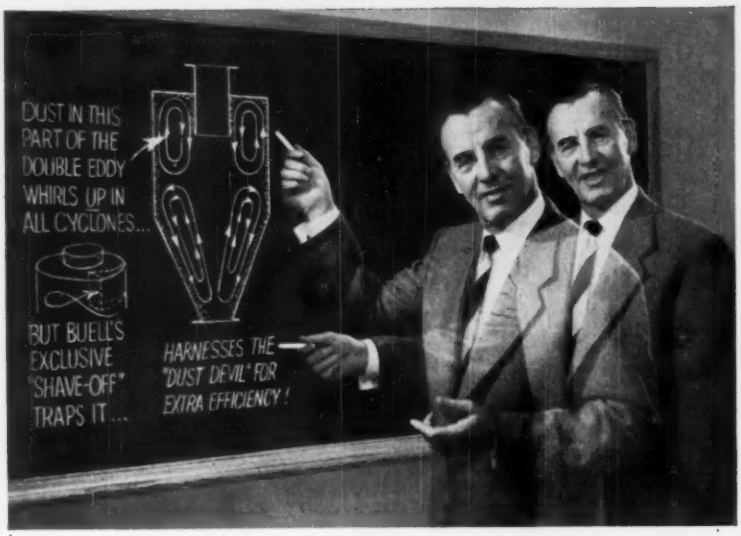
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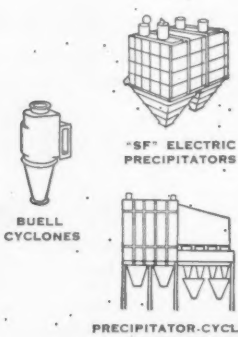

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DUST COLLECTION SYSTEMS

M-d turbines

Continued from page 88

bine must be used. Sometimes this needs only a slight increase in nozzle area at a small added cost.

Variation in stage efficiency depends on how the individual losses vary with load. The more important losses include:

1. Rotation losses—wheel-disk friction and churning of steam by buckets in a partial-arc stage
2. Radiation and convection losses—reduce available Btu
3. Leakage losses in gap between nozzles and rotating buckets
4. Packing leakage losses—for diaphragm stages
5. End losses—on partial-arc stages, caused by acceleration and deceleration of steam in buckets as they pass in and out of the influence of active arc of nozzles

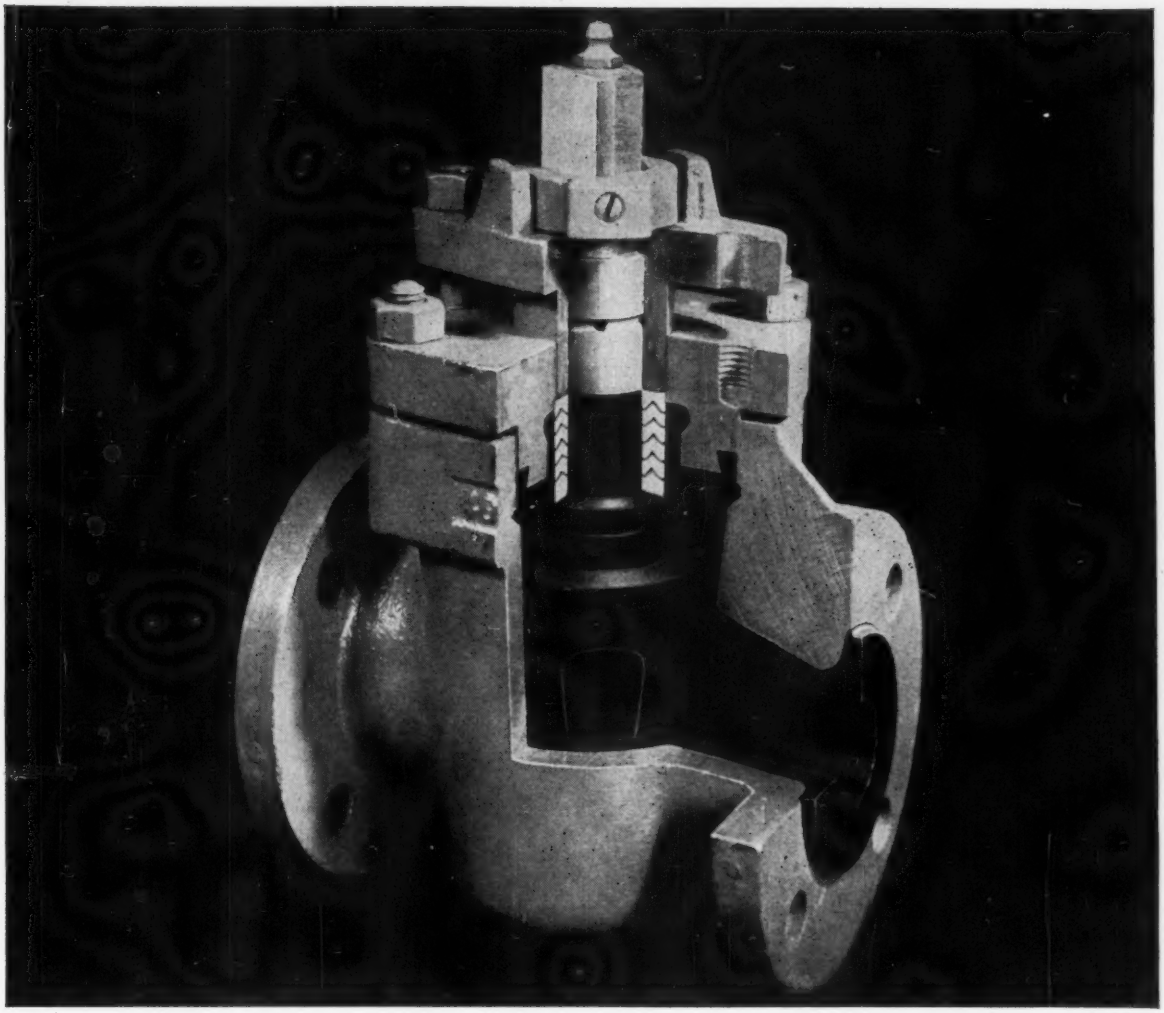
These losses may add to as much as 15% of the stage efficiency for small active arc, large shaft diameter stages: and for small first stages with multiple gaps between the active groups of nozzles. On the other hand, they may be as small as 1 to 5% loss for the larger areas of 360-deg active nozzle arc stages.

Fig. 3 gives actual efficiencies for single-row-wheel stages. The large heights are more efficient than the smaller. With fixed shapes of nozzle foils and buckets, Fig. 4, the top and bottom wall friction remains practically constant for a given velocity ratio, and they are smaller percentages of the stage input at the higher heights.

Suppose the stage height is reduced to a very small value. The boundary layer losses would be a very high percentage of stage output. Conversely for a large height the friction would have negligible effect on stage efficiency.

Theoretically a single-row wheel gives its peak performance at $W/V_o = 0.50$; many large-area impulse stages do peak at this ratio. But smaller-area impulse stages with the same diameter wheel peak at less than 0.50. Making the area very small by reducing the number of nozzles for a given height makes performance peak at $W/V_o = 0.25$ or less. Fig. 4 gives the approximate variation in stage efficiency with nozzle area, speed ratio, and pressure ratio P_1/P_2 not more than about 2.5.

These curves apply to wheel pitch



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M-d turbines

Continued from page 190

diameter of about 25 in. and show the best stage efficiency for areas either full arc of nozzles or partial arc with the most efficient nozzle height. Fig. 6 gives the approximate height that produces the optimum efficiency for a given area. These curves include leakage losses for a 6-in. diameter shaft. Pitch diameters other than 25 in. will have different curves.

Reaction staging. Because most small and medium capacity multistage m-d turbines have a large percentage of partial arc areas in the h-p stages they cannot use reaction staging efficiently. The high leakage losses more than offset the theoretical efficiency gain of reaction staging. Little reaction designing is used except for some high-hp m-d turbines where it may only be of incidental importance.

Some high-hp high-speed compressor-drive turbines may have warped and tapered buckets with nearly impulse conditions at the bucket root and varying degrees of expansion (reaction) along the height of the bucket to the tip. These are the exception rather than the rule.

Nuclear superheating

Continued from page 95

Fast-operating valves can isolate the containment shell which holds the reactor, pumps, emergency coolers and other reactor auxiliaries. An 18-foot deep water shield above the reactor allows "deep water maintenance" and manual refueling.

The shim-rod drives stand on top of the plug. The plug may be stored in the shield water tank during refueling or lifted out for repairs.

Refueling. One-third of the reactor fuel will be replaced three times a year. Spent fuel stored under water in the main building allows using the turbine crane to handle coffins for transporting radioactive fuel elements.

In removing spent fuel from the reactor core, the operator first removes the plug from the vessel. With the aid of a long-handled grappling tool he lifts out the radioactive fuel element from reactor core, to lower it into a chute. The chute guides the

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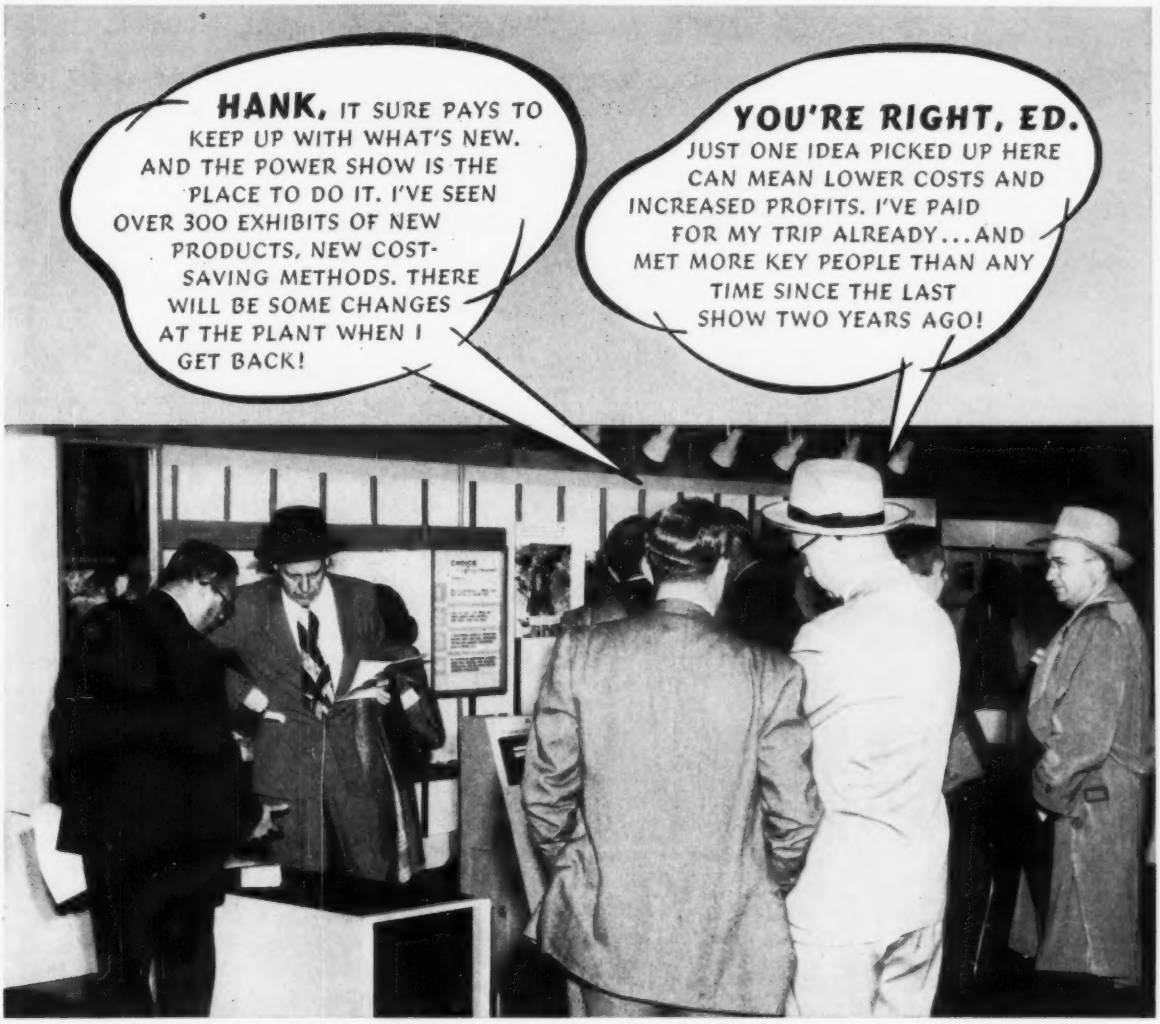
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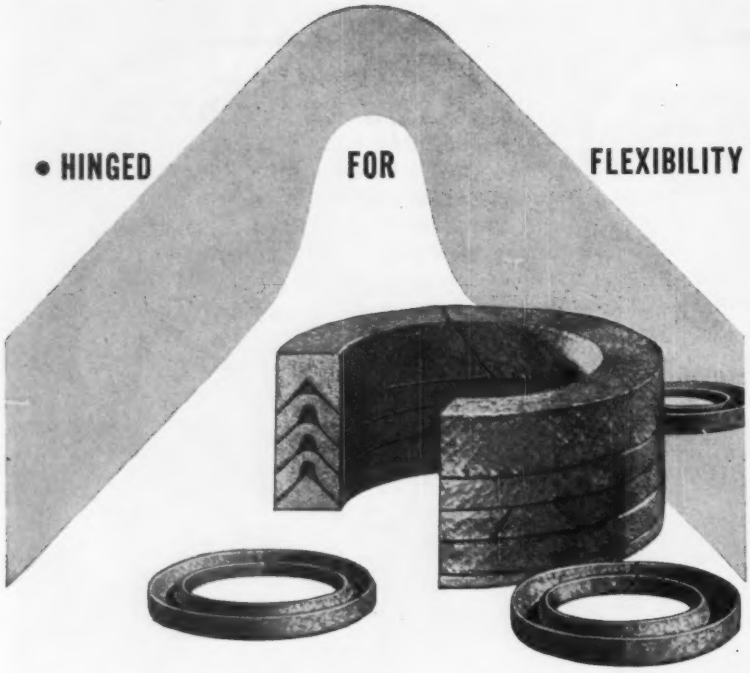

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Nuclear superheating

Continued from page 192

fuel element into the storage tank for a 60-day decay period. From here the cooled fuel is loaded into a coffin for shipment to AEC for processing.

New nonradioactive fuel elements are manually loaded into the core with the aid of the grappling tool.

Fuel elements. Aluminum-jacketed UO_2 pellets will be used in the boiling region of the core. Information on aluminum corrosion is promising at this time, but not conclusive. Several experimental loops at our laboratory will contribute further information to the excellent corrosion work being done at Argonne Laboratories and elsewhere.

Tomorrow's plants. In future plants power output may be increased proportionately by increasing pressure without change in vessel size. High-strength steel will keep reasonable vessel wall thicknesses. Increased capacity from a modest increase in capital cost will cut cost per installed kw to a favorable level.

Experience and advances in technology will lead to higher steam temperatures, higher efficiencies and lower fuel and operating costs. Still lower cost will come from further design simplification.

Extension of the conventional turbine building may house the reactor instead of a steel containment shell. Although conservatism and operating schedule prevent this step for the Pathfinder plant, feasibility of this change is under study. Resulting information will be available for further use.

When construction of very large capacity plants is justified, several superheating reactors may be used to supply a single turbine-generator. Thus a plant could be operated under partial load while refueling. It's not hard to visualize reactors being refueled quickly under pressure and possibly under load. Development of a separate steam-cooled nuclear reactor for reheating steam appears to be an interesting possibility.

Conclusions. Construction and operation of the CRBR is a logical step toward economical nuclear power. The design incorporates a number of cost-reducing features: high specific power, excellent power distribution in the core, high thermal efficiency and relatively low fuel fabrication costs.

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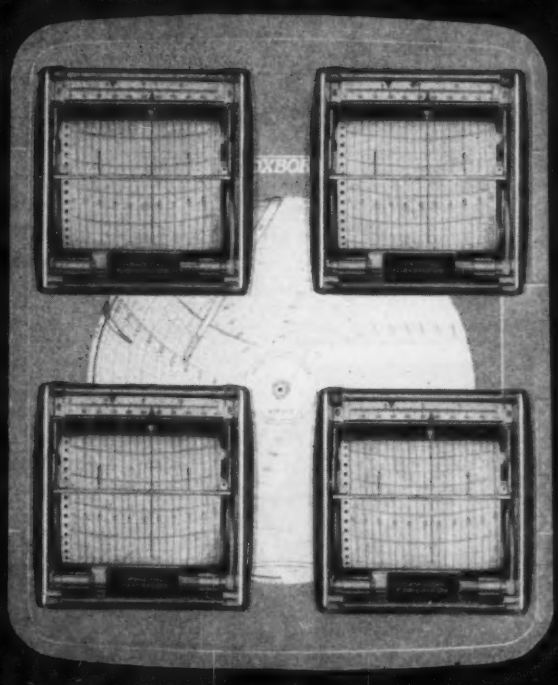

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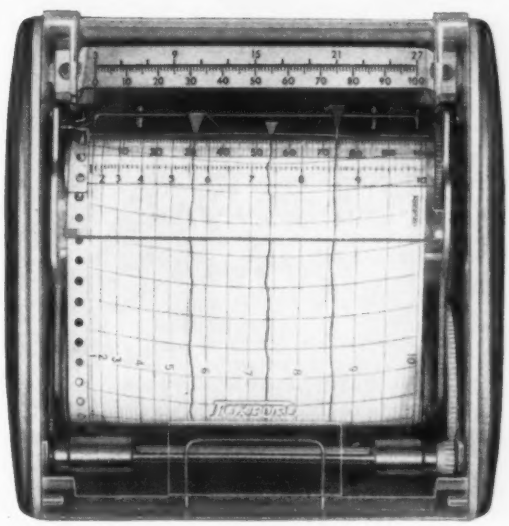

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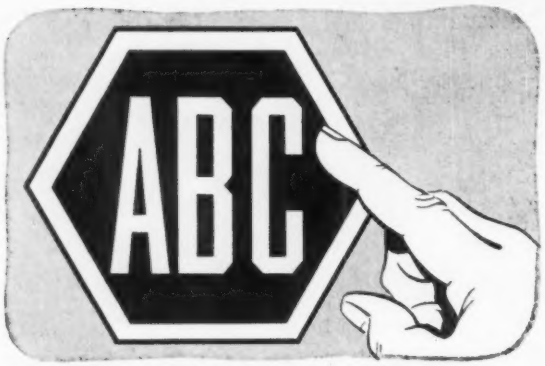

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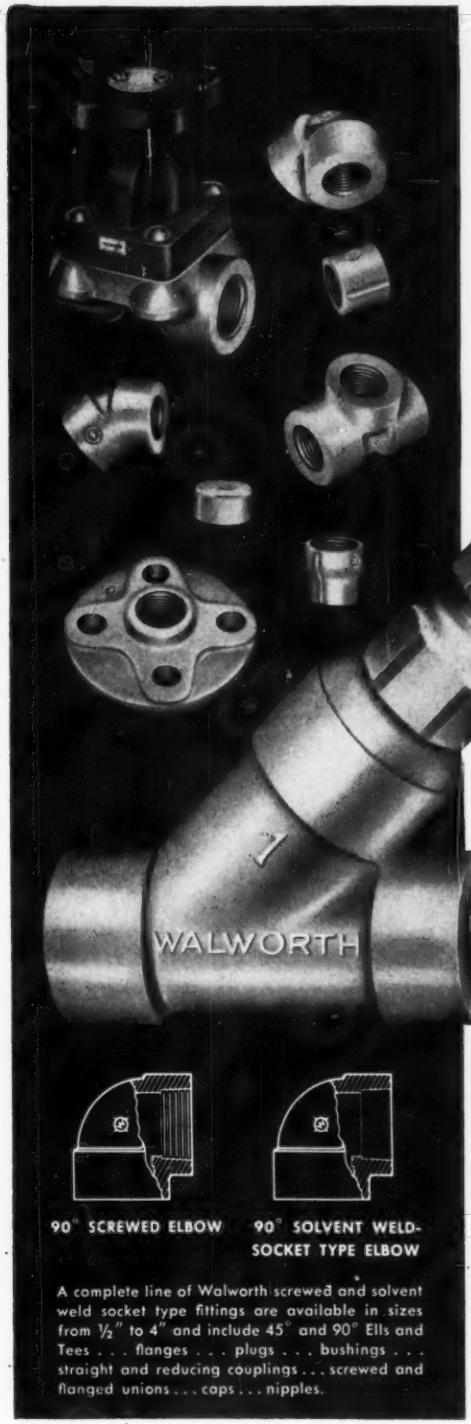

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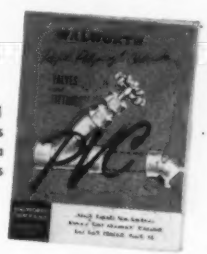

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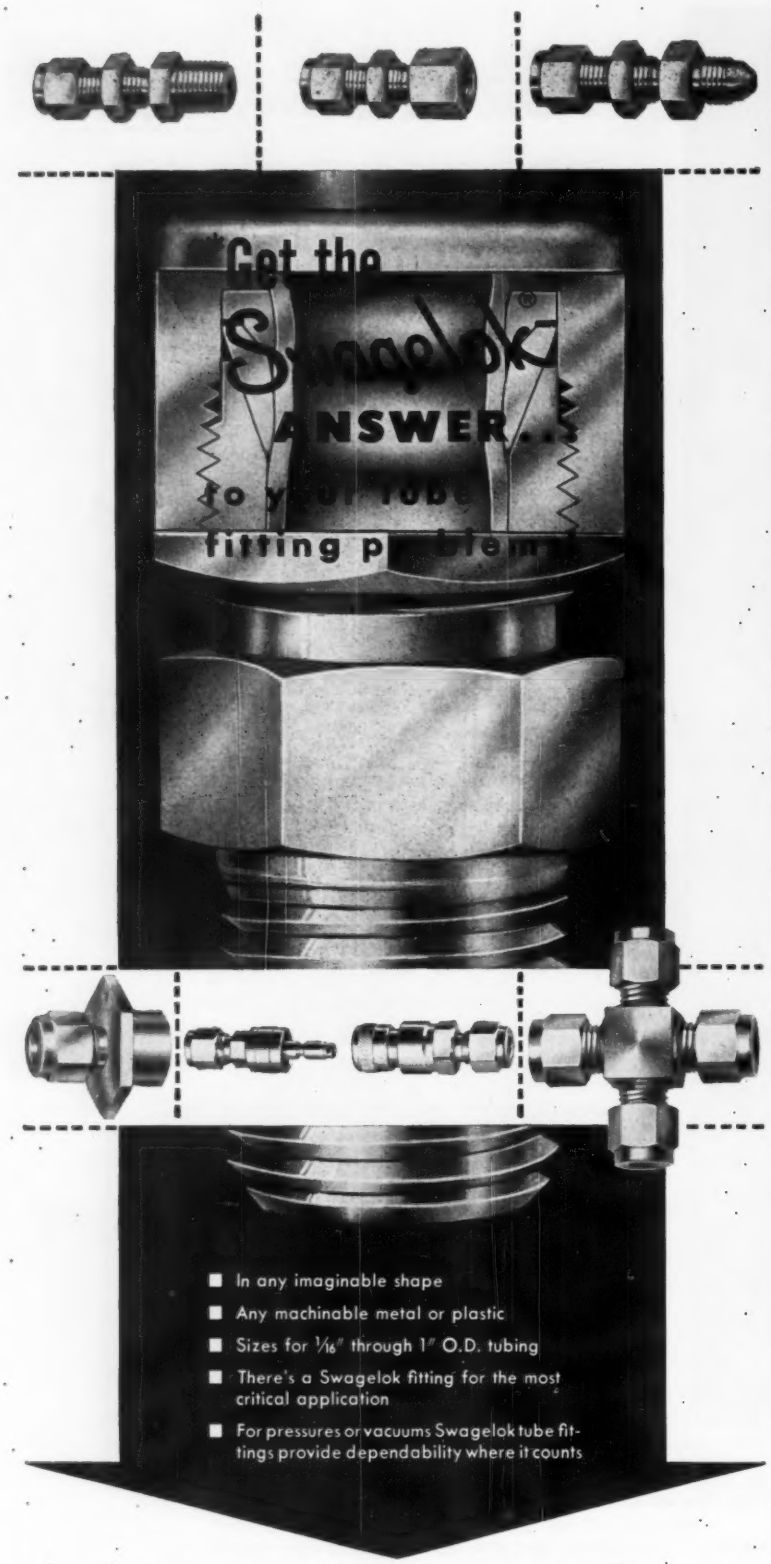
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Soot blowing

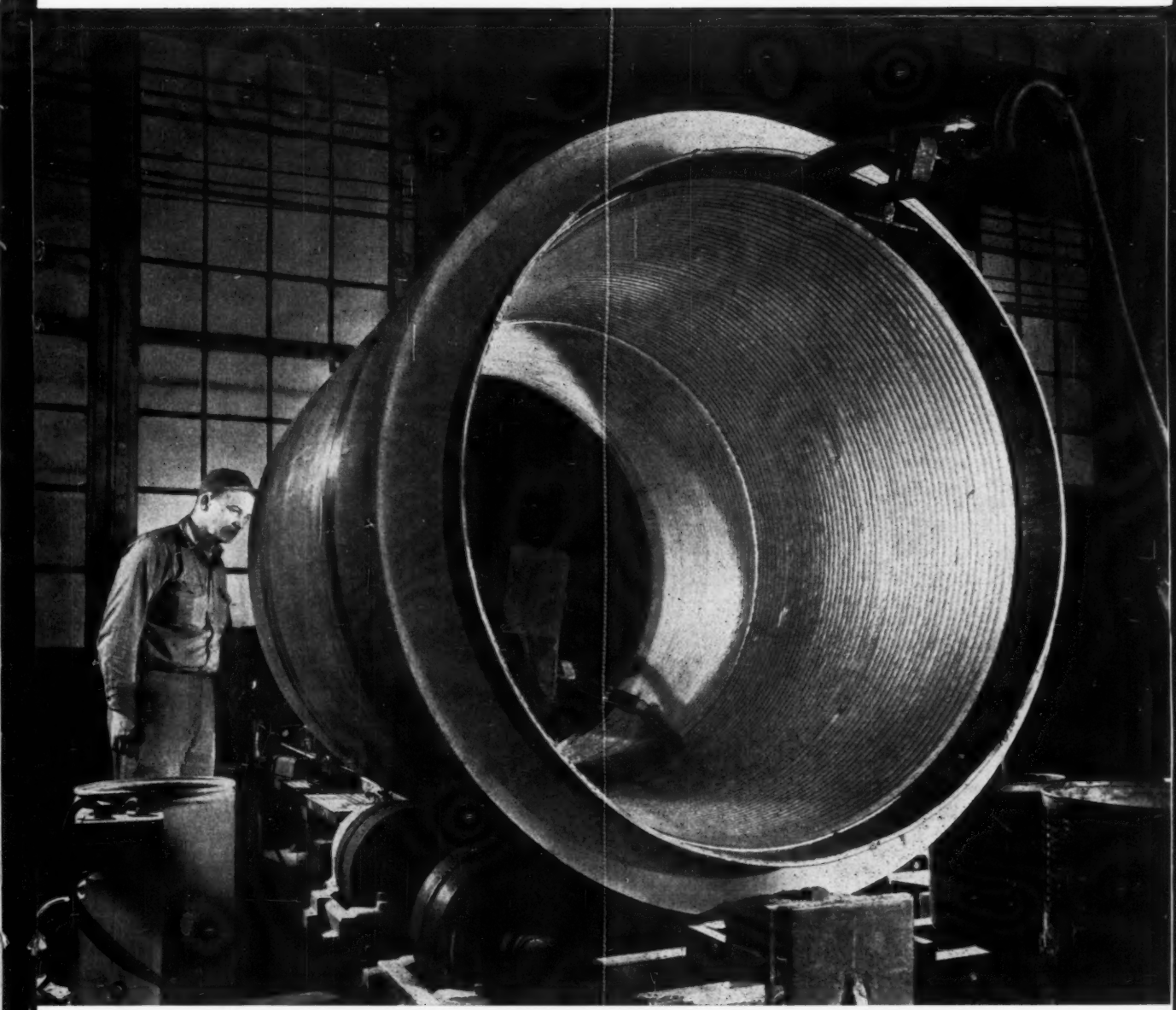
Continued from page 97

simplified by the chart, Fig. 1. Here we follow the steps for each set of conditions and readily arrive at a suitable receiver size. Dotted examples are typical for a long retracting blower under two common blowdown ratio conditions: (a) 500 to 250 psi line pressure and (b) 350 to 250 psi. Chart doesn't cover time element for continuous blowing of a regenerative air heater. However, this can be handled by setting the blower traversing and valve controls to cycle periodically to come within receiver capacity for other blower requirements.

Chart scrutiny and use will tend to clarify and justify the recent trend toward 350-psi air-compressor systems. Larger boilers, more blowers, poorer fuel and higher ratings have combined to push compressor capacity up to and beyond maximum blower use rate. This makes for less total air deficiency and a favorable case for lower compressor discharge and receiver pressures.

Spare, or reserve compressor capacity is a factor that has often affected favorable consideration for air blowing. We find a chain of cumulative safety factors being set up such as: (1) Cleaning cycle established as *maximum* probable rate. (2) Blowing pressures set at *maximum* probable levels. (3) Blower air study that includes *maximum* probable future requirements. (4) Compressor operation which is sometimes considered at *less* than full time. (5) Blower size selection is to the next *larger* step above net requirements. (6) A complete spare compressor included for reserve. Good engineering always provides a substantial margin over ideal conditions, but the above process can sometimes lead to a full capability of three or more times the ideal rate.

Review of several central station air-blowing studies indicates an average net air compressor power requirement of about 0.3% of generator output at full load and with pulverized coal or cyclone firing. This figure includes most of the above safety factors, but does not include the spare compressor. Figures from which average was drawn range from 0.1 to 0.5% and cover all usual coal types and firing methods. There are probably many units operating at



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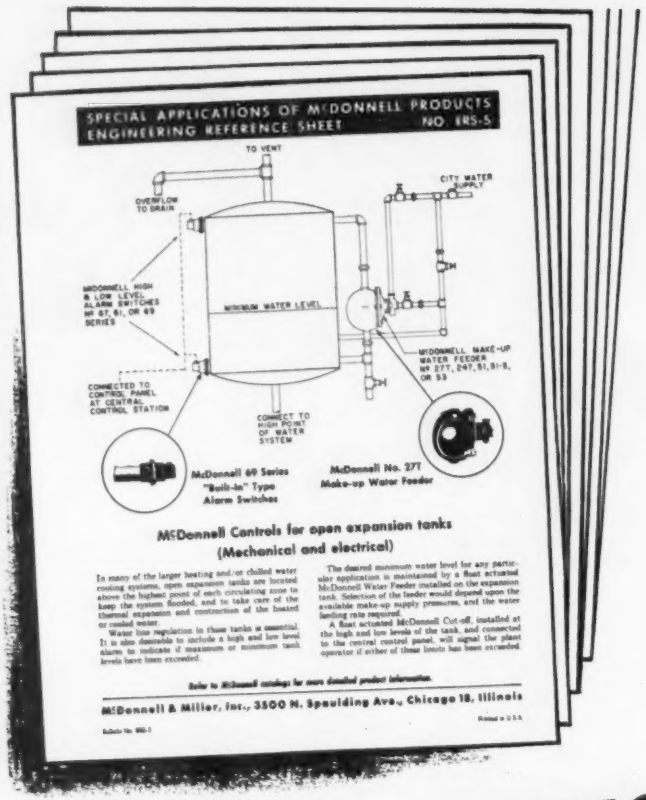
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Soot blowing

Continued from page 198

higher levels, but they are also probably operating compressors at a fraction of total time.

Spare compressor provision is a matter of major concern in evaluating air blowing and selecting compressor and receiver equipment. A spare compressor and all that goes with it (drive, coolers, controls, etc) can easily be the factor which overshadows the entire evaluation and eliminates air blowing from consideration. Complete compressor systems can cost about $60 to $75 per cfm installed capacity and a single large compressor unit could mean $100,000 or more. But compressor availability is very high and servicing can almost always be scheduled to tie in with low-load operation or boiler outages. Unscheduled outages should be below 1% of total time.

Alternative to a spare compressor is the possibility of using steam, preferably from the h-p turbine outlet, piped to the blower system for emergency use only. This would involve dual use only for blowers equivalent to one compressor output. Blower piping sizes and design would be practically the same as for air except for drainage provisions. Needed, too, would be supply and shutoff valves and "crossover" header connection, where 500-psi steam at full load could be used without pressure reducing and without blower valve and nozzle size changes for the short time it might be in use. Additional cost of this steam backup should be only a small fraction of spare compressor cost and would up overall economies appreciably.

Air-blowing system design calls for a cleaning program which is compatible with equipment sizes and operating characteristics. A healthy situation, this promotes greater cleaning economy without sacrifice in overall effectiveness. Steam cleaning has one virtue—its unlimited availability under almost any circumstances. However, this often leads to extravagance in its use.

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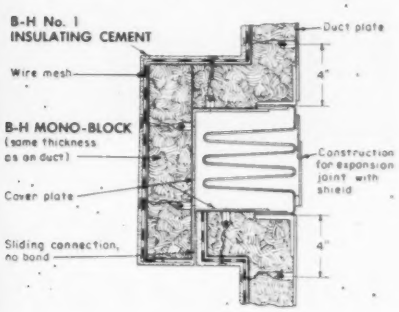

Duct Expansion Joint

An interesting application of Mono-Block is on the expansion joints where movement will exceed 3". Block was applied to two independent sections capable of sliding with respect to each other.

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For more information on B-H Mono-Block, B-H No. 1 Insulating Cement and other B-H Insulations, write for catalog or see it in Sweet's Plant Engineering File.

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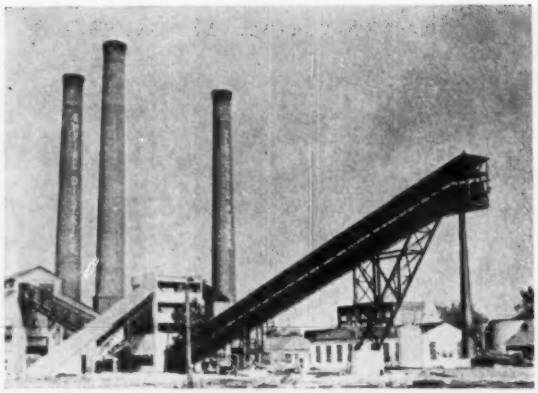
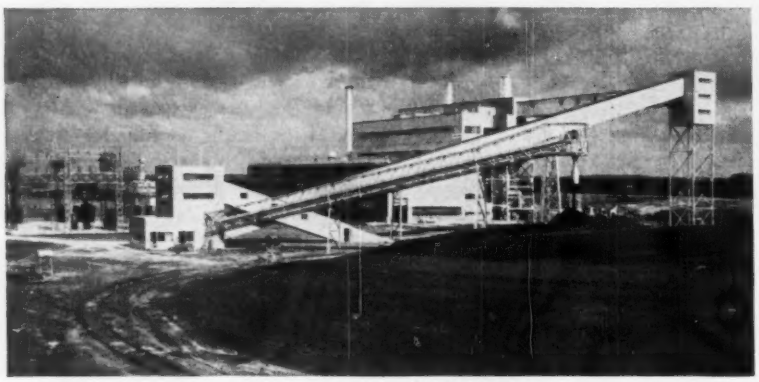


McNally Pittsburg developed this 250 ton per hour system for the EMPIRE DISTRICT POWER & LIGHT CO.



McNally Pittsburg assisted in developing this 300 ton per hour system for the KANSAS POWER & LIGHT CO.

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Soot blowing

Continued from page 200

in quick sequence and in near proximity so little or no benefit is obtained from the 'fringe" cleaning ability of each blower. Gradual fouling of all surfaces occurs without any cleaning. Then cleaning is done intensively—with appreciable range overlap in many areas—within a rather short time. This is followed by another cycle of fouling and cleaning—and so on.

Boiler designers generally agree that a uniform condition of fouling and cleaning is more desirable. Air blowing, by its basic nature, involves a cleaning cycle "stretch-out" and gives a much nearer approach to such uniformity. Field surveys show that slow gradual cleaning as opposed to fast intermittent cleaning pays off in better superheat, reheat and exit gas temperature control.

Boiler cleaning is "big business." It involves high initial capital investment in blower equipment and facilities and can pose a significant permanent operational and maintenance cost burden. It's obvious that this warrants a careful and thorough analysis of the total relative picture of air or steam cleaning for projected units.

Free literature

Begins on page 153

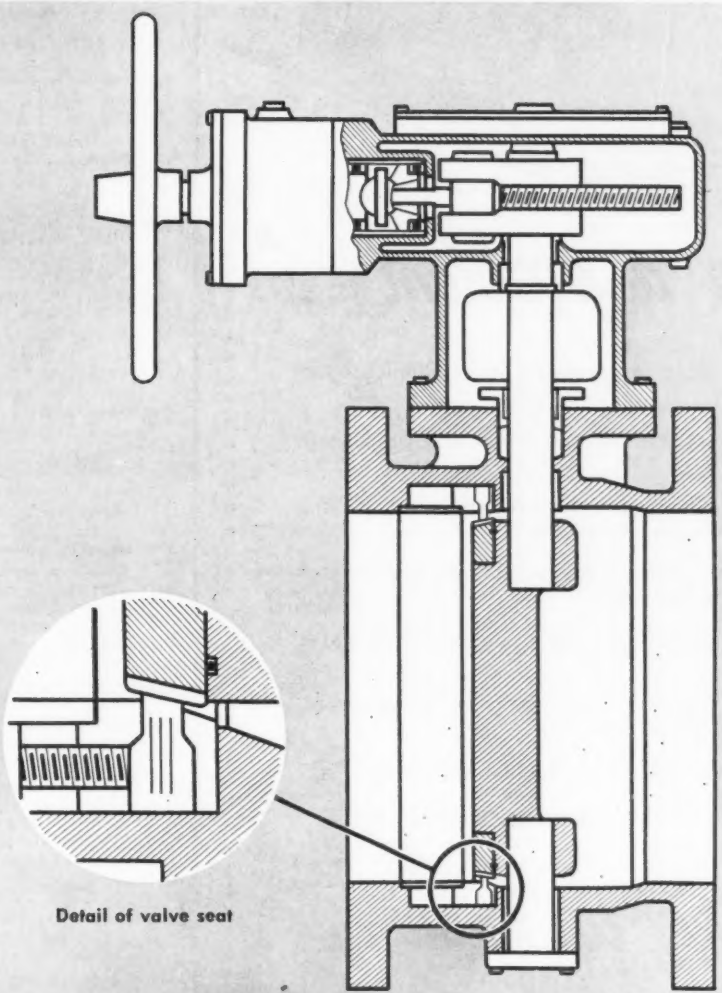
10 **Metalclad switchgear** operation, characteristics and application is subject of 40-p bulletin GEA-5664E. Indoor and outdoor switchgear, rated 2.4 to 13.8 kv with interrupting capacities of 75 to 1000 mva, are included. General Electric Co, Schenectady 5, N. Y.

11 **Aluminum rigid conduit** is covered in 12-p booklet MU-28. Outlines mechanical and electrical advantages, gives installation photos. Aluminum Company of America, 749 Alcoa Bldg, Pittsburgh 19, Pa.

12 **Power capacitors** for h-v applications are discussed in 8-p bulletin GEA-6662A. Contains pictures, cutaway and dimensional drawings, ratings and weights. General Electric Co, Schenectady 5, N. Y.

13 **Integral distribution centers** rated 112½ kva and above, liquid filled, and 300 kva and above, open and

Get longer life and trouble-free performance with Pelton rubber-seated butterfly valves



Pelton rubber-seated butterfly valves are available with hydraulic cylinder, manual operator, or Pelton motor operator.

A 6-in. test valve under 50 psi with a flow corresponding to a velocity of 16 ft. in the adjacent 6-in. pipe was recently operated through 12,500 cycles (10,000 with rubber seat ring downstream of valve operating shaft, 2500 with it upstream). Periodic checks at frequent intervals revealed that the valve was absolutely droptight throughout the entire test. Similar tests conducted under 125 psi demonstrated equally outstanding performance of these butterfly valves.

Manufactured in strict accordance with AWWA standards, Pelton rubber-seated butterfly valves offer the following significant advantages:

- **Compactness**
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In addition to butterfly valves, Pelton manufactures impulse turbines, reaction type turbines, hydraulic turbine governors, spherical valves, pressure regulators, surge suppressors, waterworks valves, large centrifugal pumps, duplex strainers, dynamic balancers, etc. For descriptive illustrated bulletins, write Pelton Division (B-L-H), 2929 Nineteenth Street, San Francisco 10, Calif., or Eddystone Division (B-L-H), Philadelphia 42, Pa.

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Free literature

Begins on page 153

sealed dry, are subject of 28-p bulletin GEC-1355A. General Electric Co, Schenectady 5, N. Y.

ELECTRICAL APPLICATIONS

14 **Pre-fab system** of in-plant electric distribution is described in 4-p bulletin. Features of elements are included. Electric Distribution Products, Inc, 2210-31st St, SW, Allentown, Pa.

15 **Better elevatoring** is topic of 32-p illustrated booklet. Discusses fundamental considerations in planning vertical transportation systems. Includes electric passenger and freight elevators, escalators and plunger-electric freight elevators. Otis Elevator Co, 260 11th Ave, New York, N. Y.

16 **Open motors** for many applications formerly needing closed designs are covered in 6-p 4-color bulletin 05-51B9040. Allis-Chalmers Manufacturing Company, Milwaukee 1, Wis.

17 **Electric heaters** and heating devices are covered in 52-p catalog GEC-10051. Gives photos, diagrams, specs and pricing info. General Electric Company, Schenectady 5, N. Y.

MATERIALS HANDLING AND STORAGE

18 **Coal-handling equipment** is discussed in relation to overall plant design in 16-p booklet A-2029. Includes methods of handling coal at large and small plants, unloading, storage and reclaim, conveying and elevating, etc. Link-Belt Company, Prudential Plaza, Chicago 1, Ill.

19 **New spray** for protection of outdoor stockpiles is described in 4-p bulletin P58-1. Johnson-March Corp, Philadelphia 3, Pa.

20 **Conveyor belt** is topic of 12-p brochure M302. Drawings describe compensation, other features. Raybestos-Manhattan, Inc, Manhattan Rubber Div, Passaic, N. J.

INSTRUMENTATION

21 **Variable-area** armored flowrator meter for h-t applications, both gas and liquid service, is subject of 4-p bulletin 10A1152. Gives operational limits for standard units with ranges up to 600 psi at 100 F and 100 psi at 980 F. Fischer & Porter Co, 816 Jacksonville Rd, Hatboro, Pa.

22 **Analog computer** is described in 18-p brochure and folder. Folder is a photographic model of the unit, illustrating its "zipper" packaging. Mid-Century Instrumatic Corp, 611 Broadway, New York 12, N. Y.

23 **Propeller meters** and other water-measurement and recording in-

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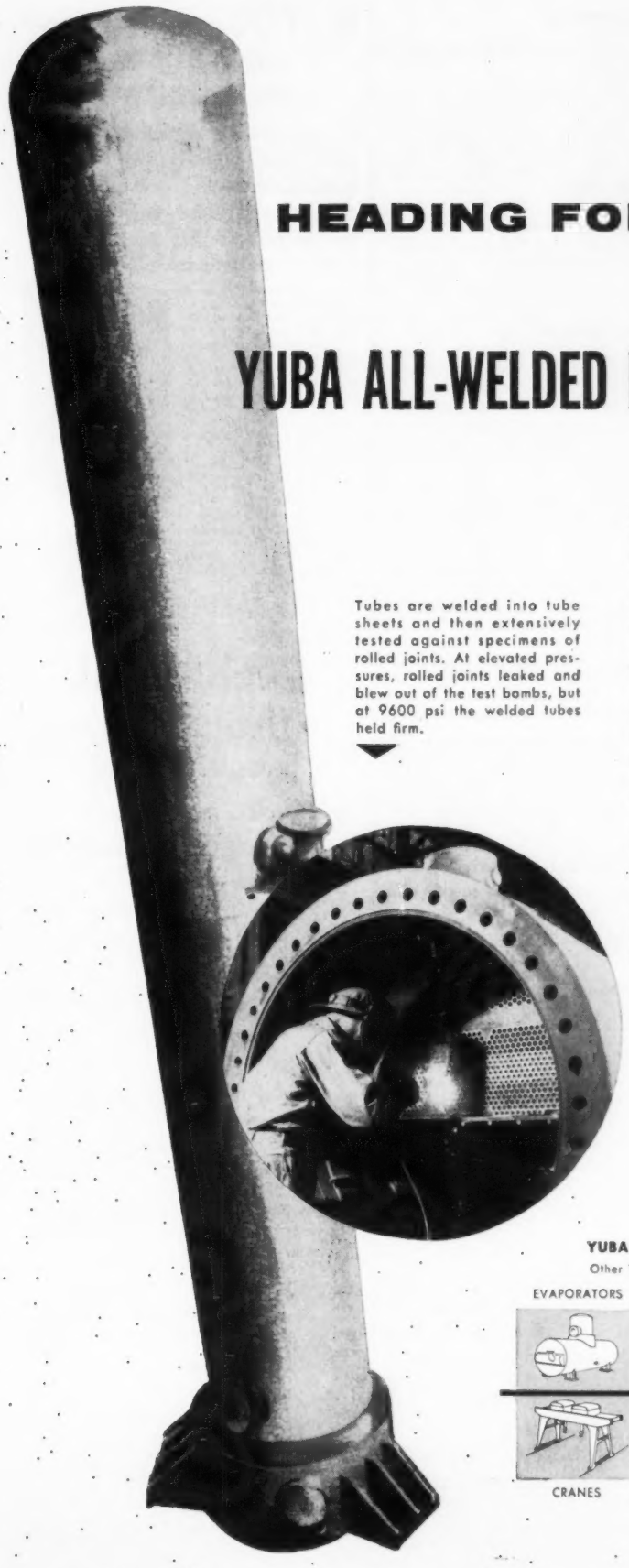

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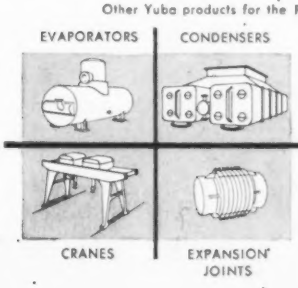

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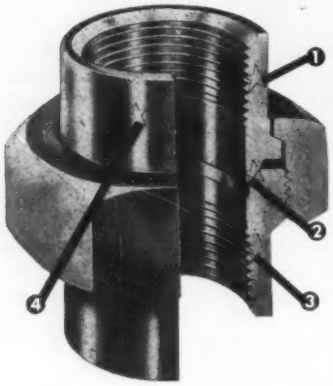

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Free literature

Begins on page 153

struments are covered in 20-p bulletin 314-1. Principles are described, performance graphs are included. Sparling Meter Company, 225 N Temple City Blvd, El Monte, Calif.

24 **Resistance thermometers** for temperatures to 1000 F are discussed in 36-p catalog EN-S4. Describes many applications, including steam, power generation. Leeds & Northrup Co, 4934 Stenton Ave, Philadelphia 44, Pa.

25 **Instrumentation** and equipment—flow tubes, telemetering, supervisory control—for process uses are listed in 8-p bulletin 100-R5. B-I-F Industries, Inc, 345 Harris Ave, Providence, R. I.

26 **Manometers** are subject of 24-p catalog 2008. Units measure pressure and vacuum in plants and labs. Complete specs included. King Engineering Corp, Box 680, Ann Arbor, Mich.

Calendar of Events

Nov 12-14—Society for Experimental Stress Analysis, Annual Meeting. Sheraton-Ten-Eyck Hotel, Albany, N. Y. Details from SESA, Box 168, Cambridge 39, Mass.

Nov 18-20—U.S. Public Health Service, National Conference on Air Pollution. Sheraton-Park Hotel, Washington, D.C.

Nov 18-20—American Standards Assn, Annual Meeting. Roosevelt Hotel, N.Y.C. Details: ASA, 70 E 45th St, New York, N. Y.

Nov 30-Dec 5—American Society of Mechanical Engineers, Annual Meeting. Statler and Sheraton-McAlpin Hotels, N.Y.C. Details from ASME, 29 W 39th St, New York 18, N. Y.

Dec 1-5—23rd National Exposition of Power and Mechanical Engineering (Power Show). New York Coliseum. Details from International Exposition Co, 480 Lexington Ave, New York 17, N. Y.

Dec 1-3 — American Society of Refrigerating Engineers, Semi-Annual Meeting. Roosevelt Hotel, New Orleans, La.

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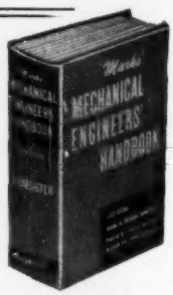

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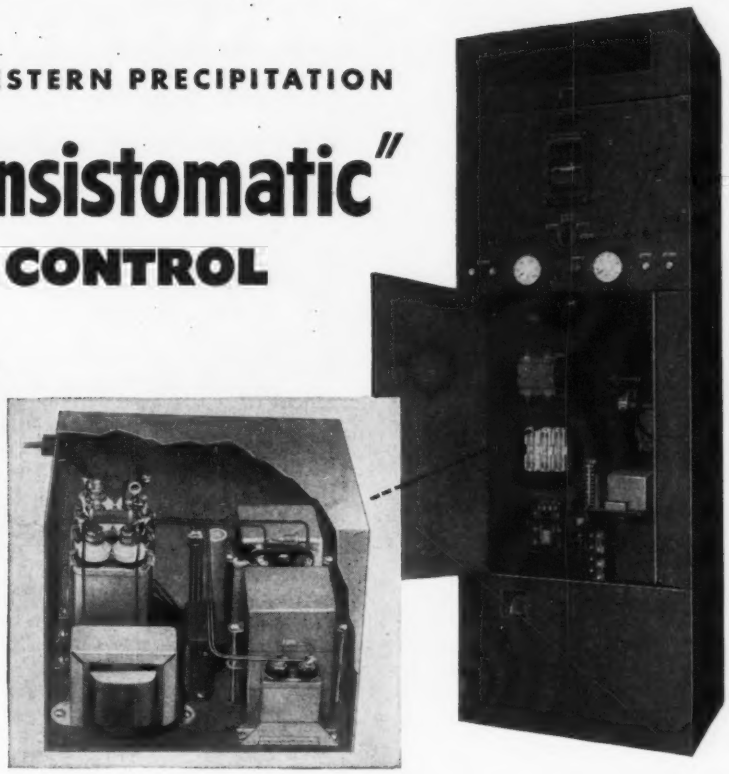

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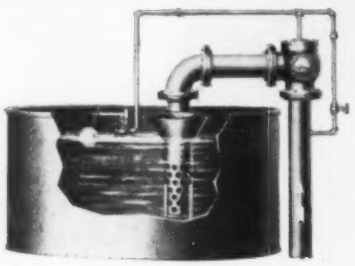

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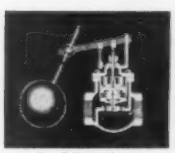

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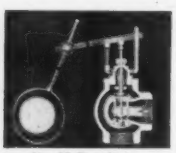

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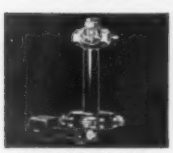

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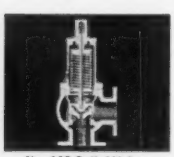

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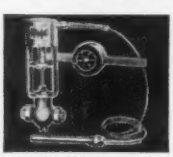

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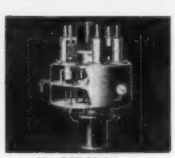

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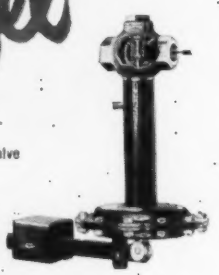

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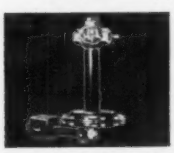

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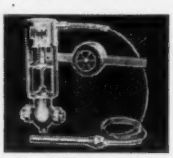

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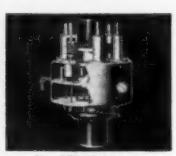

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new high pressure closure for Ross feedwater heaters

Open for your inspection, during tube welding, this is the business end of a Ross Feedwater Heater. Take an inside look at the most unique High Pressure Closure in the business. It's brand new.

Only four major parts complete the assembly and she's ready to perk . . . pass partition cover, channel cover, two flange rings. That's all *you'll* need to handle at maintenance time. *Simple* is the word!

. . . so is *ruggedness*. The exceptionally high safety factor built into the load carrying cover and channel is more than double ASME Code requirements. Construction prevents overload of main engagements when tightening studs. Differential expansions between channel and cover do not effect channel wall, while bearing surfaces are spaced identically for uniform load. Temperature stresses from start-ups or load changes are virtually non-existent. There's more . . . much more!

American-Standard and Standard ® are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
ROSS HEAT EXCHANGER DIVISION

NEW BULLETIN

You'll have to see the detailed design features of this new Ross development to fully appreciate the tremendous advantages. They are illustrated and described in new Bulletin 201.1K1. Mail coupon for your copy.

AMERICAN-STANDARD
ROSS HEAT EXCHANGER DIVISION
BUFFALO 5, N. Y.

Please send your new Bulletin 201.1K1 describing high pressure closures for Ross Feedwater Heaters.

NAME _____ TITLE _____

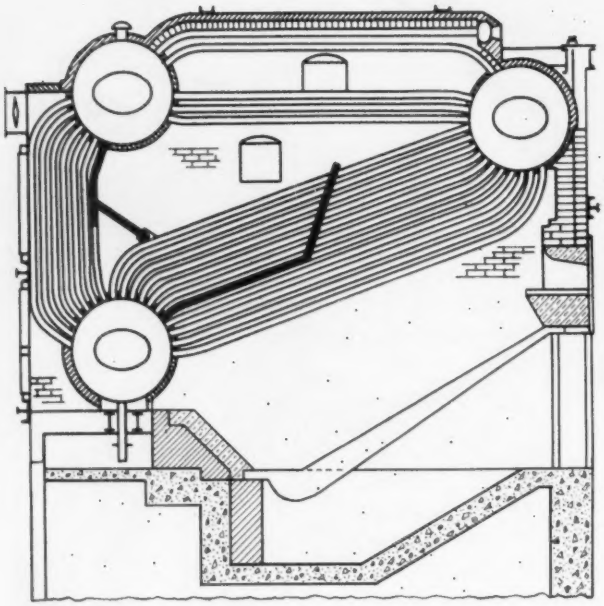
COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

PM1158

HOW YOU CAN MOVE YOUR PRODUCTS...



Take a tip from
BOILER MANUFACTURERS

. . . the starting point for all the plant services. Year after year companies selling boilers to industry use more advertising pages in POWER than in any other magazine in the world.

During 1957 POWER carried a total of 254 pages of advertising placed by these manufacturers of boilers of all sizes:

the companies

Ames Iron Works, Inc.
Babcock & Wilcox Co.
Bigelow Co.
Bros Inc.
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Combustion Engineering, Inc.
Cyclotherm Div., National-U.S. Radiator Corp.
Erie City Iron Works
Foster Wheeler Corp.
E. Keeler Co.
Kewanee Boiler Div., American-Standard
Murray Iron Works Co.
Orr & Sembower, Inc.
Preferred Utilities Manufacturing Corp.
Riley Stoker Corp.
Superior Combustion Industries, Inc.
Titusville Iron Works Co., Div. of Struthers-Wells Corp.
Union Iron Works
Vapor Heating Corp.
Henry Vogt Machine Co.
Wickes Boiler Co.

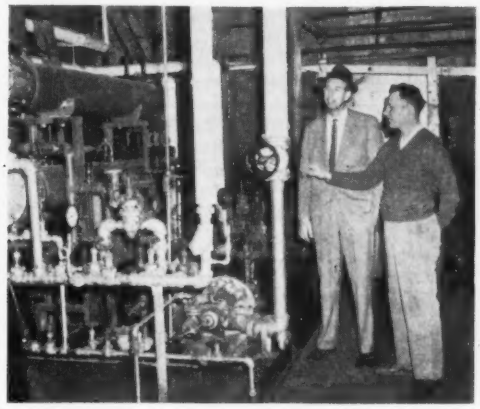
Boiler manufacturers know POWER gives them most for their dollar.

You too, will find that **POWER IS THE ONLY FULL-VALUE PUBLICATION SERVING THE POWER AND PLANT SERVICES MARKET.**

IF YOU WANT TO MOVE YOUR PRODUCT, . . .

...TO MEN IN INDUSTRY

the men ...



Plant Engineer, H. M. Montague, with his Foreman, J. D. Gowell, at Armstrong-Norwalk Rubber Corp., Norwalk, Connecticut.

the industry ...

Armstrong-Norwalk Rubber Corp., subsidiary of Armstrong Rubber Co., manufactures Foam Rubber for Furniture and Mattresses as well as rubber for Tire Recapping and Shoe Soles.

Mr. Montague, as plant engineer, specifies equipment that generates, distributes and applies *all* the following services:—steam (for processing and heating), electricity, water (for fire, sanitation, process and drinking), compressed air, air conditioning, ventilation, refrigeration, materials handling and lubrication.

Mr. Gowell is responsible for the entire boiler plant as well as air compressors and piping throughout the plant.

About POWER Mr. Montague says—"In the production of a top grade product these plant services are all-important. It's a big engineering job and that's where POWER comes in, as primary guide to better engineering practices. Advertising? We're always looking for new products and more efficient processes. We get lots of tips from the advertising pages."

And Mr. Gowell adds—"Copies are routed through the plant, but I subscribe to POWER at home where I can give it more time. I like the fact that even the most technical subjects are written about in a way that makes them easy to understand."

The POWER and PLANT SERVICES
We have prepared a booklet explaining in detail what these services are, their use in specific industries, their future and their importance to you. Write for your copy.

...PUT Power BEHIND IT!

A McGRAW-HILL PUBLICATION, 330 WEST 42nd STREET, NEW YORK 36, N.Y.

ABP ABC

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CONSULTING DESIGN EXAMINATIONS PATENTS
CONSTRUCTION PLANS SURVEY • REPORTS TRADE MARKS

BEISWENGER, HOCH AND ASSOCIATES
Consulting Engineers
Surveys, Design, Field Supervision,
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PIONEER SERVICE & ENGINEERING CO.
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Specialists in Water Treatment for corrosion Prevention
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615 West 131 Street New York 27, New York
Offices also in Phila., Wash. & Richmond, Va.

CHAS. T. MAIN, INC.
CONSULTING ENGINEERS
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Featuring additional products, specialties & services for power plants

PAINTING CONTRACTORS
Specialists in
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STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF Power, published Monthly at New York, N. Y. for October 1, 1958.

1. The names and addresses of the publisher, editor, managing editor, and business manager are: Published by McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York 36, N. Y.; Editor, L. N. Rowley, 330 West 42nd Street, New York 36, N. Y.; Managing editor, J. J. O'Connor, 330 West 42nd Street, New York 36, N. Y.; Business manager, George A. Keates, 330 West 42nd Street, New York 36, N. Y.

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McGRAW-HILL PUBLISHING COMPANY, INC.
By JOHN J. COOKE, Secretary

Sworn to and subscribed before me this 6th day of September, 1958.
[SEAL] JANET A. HARTWICK
(My commission expires March 30, 1959)

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

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The advertising rate is $20.50 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

EMPLOYMENT OPPORTUNITIES — $47.40 per inch subject to agency commission.

INFORMATION:

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

An ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page.

UNDISPLAYED RATE

(Not available for Equipment Advertising)
$2.10 a line. Minimum 3 lines. To figure advance payment count 5 average words as a line. (See ¶ on Box Numbers.)

POSITION WANTED undisplayed rate is one half of above rate, payable in advance.

BOX NUMBERS count one additional line.

Send New ADS or Inquiries to Classified Adv. of Power, P. O. Box 12, New York 36, N. Y., for December Issue Closing Nov. 7th

NUCLEAR ENGINEERS
SALARIES TO $15,000.00 PER YEAR.
Monarch Personnel has at this time several lucrative positions for engineers with experience in the nuclear field. We are a national organization with offices in 51 principal cities throughout the U.S. Your resume is requested and complete confidence assured. All employment expense will be assumed by company clients.
MONARCH PERSONNEL
28 East Jackson Blvd., Chicago 4, Illinois

ADDRESS BOX NO. REPLIES TO: Box No.
Classified Adv. Div. of this publication.
Send to office nearest you.
NEW YORK 36: P. O. BOX 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

POSITIONS VACANT

Wanted—University graduate Engineer with at least five years experience operation steam electric generating station for responsible position in Maracaibo, Venezuela. Preference will be given Spanish speaking applicant. Salary dependent on qualifications. P-8319, Power.

E. E. Familiar with generating and distribution equipment such as alternators, transformers protective equipment, yard and substation units. Job requires top grade engineer 35 to 55 years with experience operating modern equipment. Permanent connection with old established corporation. P-8780, Power.

Electrical Engineer, licensed. Institutional, schools, commercial and industrial work. Frank L. Hope & Assoc., 1447 Sixth Avenue, San Diego, Calif.

Wanted—Superintendent of Public Utilities with diesel plant and distribution system experience for town of 2300. P-8986, Power.

Chief Engineer for 44,000 KW Steam Generating Plant now under construction, Sea Coast, Southern Peru. The applicant must be capable of taking responsibility for the Operation and Maintenance and should have five to ten or more years Central Station experience. For details as to salary, living conditions, etc. contact Mr. J. L. Splane, 410 Arizona Land Title Bldg., Tucson 1, Arizona.

SELLING OPPORTUNITY OFFERED

Wanted — Manufacturer's Agents to sell line of combustion and process controls and instruments. Choice territories available. RW-8864, Power.

POSITIONS WANTED

Mechanical Engineer, age 33, B.S., registered, 7 years steam power plant design and construction, 2½ years nuclear component development. Desire position with power company in operation, maintenance, construction. PW-8894, Power.

Steam Supervisor, 32, 17 years experience Marine and Stationary steam plant design, construction, operation and maintenance, Personnel administration and plant management. British Columbia Certificate of Competency. Desire Chief Engineer position University, Hospital or similar located temperate climate preferably West. PW-9066, Power.

WANTED

Anything within reason that is wanted in the field served by Power can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

ELECTRICAL OR MECHANICAL ENGINEERS

for Naval Nuclear Power Plant Development

The Central Technical Department of Bethlehem's Shipbuilding Division, an experienced organization recognized for its technical achievements, offers unusual opportunities for engineers qualified to participate in our nuclear power program.

CONTROL ENGINEERS: Development of control, instrumentation, and monitoring systems, and functional arrangement of control and operating stations.

ELECTRICAL ENGINEERS: Overall design of electric power system, systems analyses, and development of installation details for special applications.

Minimum qualifications for these positions are:

1. B. S. in electrical or mechanical engineering
2. Advanced study at a graduate level—preferably in electronics, servo-mechanisms or nuclear engineering
3. Four years experience in marine or closely allied industry
4. U. S. citizenship

If you would make full use of your professional training in creative engineering, enjoy easy commuting and have convenient access to New England's educational and recreational facilities, you are invited to write to us. Your inquiry will be considered confidential and acknowledged promptly.

Please address your résumé to:

BETHLEHEM STEEL COMPANY
Shipbuilding Division
CENTRAL TECHNICAL DEPARTMENT
Quincy 69, Massachusetts
Attention C. H. GOLDTHWAITE, *Assistant Manager*

WE PAY $ CASH $
FOR
Electric Motors • Starters • Transformers
Circuit Breakers—Electric Supplies
ALLIED ELECTRIC CO.
710 N. MAIN ST., MEMPHIS, TENN.
BOX 1838—PHONE JA 7-1681

WANTED
Complete power plants, turbo generators, Boilers, Condensers, Engine generators, Processing Plants and equipment.
PAUL OBERMAN
1910 Delmar St. Louis, Mo.

GET CASH NOW
for your new surplus motors, controls, and transformers!
AVAILABLE: NEW MOTORS
Over 3,500 new motors in stock from 1/4HP to 200 HP. Special low prices.
Write, wire or phone collect!
AJAX ELECTRIC MOTOR CORP.
P.O. Box 262, Rochester, N.Y.
Long Distance Phone: LD 132

LEFAX
TECHNICAL DATA BOOKS
POCKET SIZE • LOOSE LEAF
Loose leaf, 6 hole, 6¾"x3¾" bond paper, each book approx. 140 pages of technical data for student, engineer, technical worker. $1.25 ea.

Architecture	General Math	Phys. & Thermo.
Home Heating	Math Tables	Data
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Write for FREE catalogs (2000 listings). Send $1.25 for each book or $6 for any five books to
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FOR SALE
600 KW (725 HP) 1818 RPM Induction Generator 3/60/440 90.5 PF Encl. Pipe Ventilated.
150 KVA Marcus 2400/4160—240/480 Type S, Spec. #1386 80°C. Dry Type 3/60, 1.4 Imp. Add. Pol. #68888-648.
150 KVA Eisler 2400/4160—240/480 Type XC, Spec. #2330 1.4 Imp. 75°C.
NATIONAL ELECTRIC SERVICE CO.
321 Lombard St., St. Louis 2, Mo.
CHestnut 1-4603

ELECTRICAL POWER EQUIPMENT

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	HP	Make	Type	Volts	Speed
1	1750	G.E.	M-579BS	4800/2400	1800
1	1500	G.E.	SF3058	4800/2400	1800
1	800	Whse.	CW	550	1776
1	700	Al. Ch.	D.P.	2300	500
1	600	Whse.	CW-432D-18	440	1778
1	500	G.E.	MT-412	2200	439
1	500	Whse.	CW	550	350
1	350	Cr. Wh.	SIZE-718R	203/406	1763
1	350	G.E.	IM-17A	440/2200	720
1	350	Whse.	CW-1030C	440	720
1	350	G.E.	MT-424Y	4000	257
1	250	Cr. Wh.	SIZE-290	2300	350
1	250	A.C.		550	600
1	250	G.E.	MT-563Y	440	875
1	250	Whse.	CW-1010	2200	435
1	200	Whse.	CW-874D	220	885
1	200	G.E.	TE-13B	220	1760
1	200	G.E.	IM	2200	580
2	200	G.E.	IM	2200	435
2	200	Whse.	CW-890	2300	1775

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
1	500	G.E.	FT-559AY	2200	3600
1	350	Whse.	CS-1115	2300	900
4	500	Whse.	CS-1216	2200	500
3	500	G.E.	KF	2300	3600
2	450	Whse.	CS-1420	2300/4150	354
2	400	Whse.	CS-7151-810H	6600/4000	3565
1	400	G.E.	LK	2200	500
1	300	Whse.	CS-1002	2300	600
1	200	Whse.	CS-963H	2300	1175/878
1	200	G.E.	KT-557	440	1800
2	200	Whse.	CS-8558	220/440	1750
1	150	G.E.	CS	440	550

SYNCHRONOUS

1	7000	G.E.	ATI	2240/6600	600
1	4250	C.W.	3501-SL	13806/6900	514
1	3500	G.E.	TS-843BP	2300/4000	300
2	1750	G.E.	ATI	2300	3600
1	1750	G.E.	TS	2300	900

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2100/1750	G.E.	514	250/350	2300/4800
1	2000	G.E.	514	650	2300/4800
1	1500	G.E.	720	600	6600/13200
1	1500	G.E.	600	600	2300/4150
1	1000	G.E.	900	260	6600
2	1000	G.E.	720	600	6600/13200
1	750	G.E.	720	275	6600/13200
1	500	Whse.	900	125/250	440
1	350	G.E.	900	125	440/2300/4160
2	300	G.E.	1200	250	2300
1	250	Whse.	1200	275	2300
1	200	El. Mfg	1200	250	2300/4600
1	300	Whse.	1200	600	2300
1	200	Whse.		650	2300
1	200	G.E.	1200	250	550/2300
1	200	Cr. Wh.	1200	250	440
1	150	Whse.	1200	275	2300
1	100	G.E.	1200	250	4160/2400

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	7500	Whse.	650# condensing, 125# auto extraction, 6900#.
1	5000	G.E.	400# surface condenser 2400/4150 volts.
1	4000	G.E.	400# surface condenser 2400/4150 volts.

TRANSFORMERS

Qu.	KVA	Make	Type	PH.	Voltages
3	3333	Whse.	OISC	1	13800x2300
3	1000	G.E.	OISC	1	13800x460
2	750	G.E.	FUR	1	4800x55/55
3	500	KUHL	OISC	1	13600x4000
1	225	Marcus	Air	3 auto	208/220
3	100	G.E.	OISC	1	22900x2400/4160Y
3	100	Whse.	OISC	1	4600x460/230/115

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltage
3	6750	G.E.	60/25/60	13200/13200
1	5000	G.E.	60/50/60	11000/6600
2	2500	G.E.	25 cy/62.5	2300/2300
1	500	Al. Ch.	25/60	11000/2300
1	200	G.E.	60/3000	440/880

COMPINATION MILL DRIVES—
D.C. MOTORS WITH M.G. SETS & CONTROLS
PACKAGE DRIVES IN STOCK

1—2250 HP Elliott 300 V. 200/300 RPM DC Motor with 2400 KW GE MG Set. 300 V. DC 2300/4600 V. 450 RPM 3 ph. 60 cy.
1—1375 H.P. G.E., MCF. 415 V. 1300 RPM D.C. motor with 1100 KW G.E. MG Set 415 V DC. 2300/4000 V. 720 RPM 3 ph. 60 cycle.
1—1200 HP G.E. MPC. 600 V. D.C. Motor, 450 RPM, and 1000 KW. G.E. M-G Set, 600 volt DC with 1400 KP. .8 PF. Synch. Motor 13200/6600 volt, 3 ph. 60 cy.

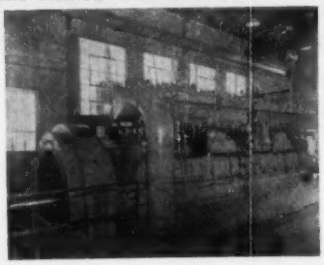
RE-NU-BILT BY

BELYEA COMPANY, INC.

43 Howell St., Jersey City 6, N. J.
Tel: OLDFIELD 3-3334

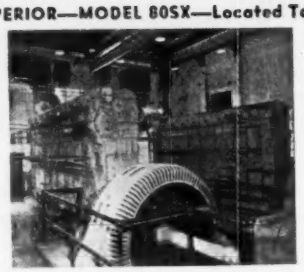
• AVAILABLE FOR IMMEDIATE DELIVERY •

1400 KW FAIRBANKS MORSE—MODEL 33F16—Located Honolulu, T. H.



- New 1948
- Less than 15,000 hours total operation
- Will convert to dual fuel

1000 KW SUPERIOR—MODEL 80SX—Located Tavernier, Fla.



- New 1951
- Less than 15,000 hours operation since rebuild
- Will convert to dual fuel

Units Can Be Seen in Operation in Present Locations

• WRITE FOR DETAILED SPECIFICATIONS •

DIESEL ENGINES — POWER MACHINERY
100 KW to 1500 KW
Diesel Generator Sets • Stationary • Portable • Mobile Motors and Generators

A. G. SCHOONMAKER COMPANY, INC.

Box 516, Sausalito, Calif. EDgewater 2-1490 — 50 Church St., N.Y. 7, N.Y. DIgby 9-4350

GUARANTEED "REBUILT" POWER EQUIPMENT

SQUIRREL CAGE MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
1750	*G.E.	K	3600
1750	*G.E.	K	1800
1200	*Al.-Ch.	ANX	3600
800	West.	CS	720
600	*G.E.	K-83455	1200
600	*G.E.	K-85455	1200
500	*G.E.	I-13-E	900
350	*G.E.	KT-558-A	1800
300	*G.E.	KS344	1200
250	*W (TE)	CS-81205	1800
250	*G.E.	KT-599-S	1800
250	*West.	CS-875-S	1800
250	Brook	R828	1200
200	*G.E.	FT-540	3600
200	West.	I-K-13B	1800
200	Brook	CSP-581-S	1800
200	*West.	RS-27	1200
200	G.E.	CS-950-A	900
200	*Al.-Ch.	KT-584-S	720
200	*West.	AN-37-G	720
200	Al.-Ch.	CS-1010	600
200	*G.E.	ARW-851	600
150	Cr-Wh	SC-140	3600

SQUIRREL CAGE MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
150	Al.-Ch.	AN 30-F	1200
150	West.	CSP-5815	1200
150	G.E.	I-K-18A	900
150	*West.	CS	900
125	Al.-Ch.	AR-226	1800
125	G.E.	5-Q	1200
125	Cr-Wh	K-558	900
100	W (TE)	CS-507-S	3600
100	G.E.	FT-542-Z	1800
100	Al.-Ch. (TE)	ARZ-528	1200
100	Al.-Ch.	AW-23D	1200

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
2500	*G.E.	MT (Mill Type)	257
1100	*G.E.	MT	720
1000	*G.E.	M-575-S	1200

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
1000	*West.	CW	450
600	*G.E.	M-8345-S	1800
500	G.E.	M-8345	1200
400	*G.E.	MTP-565	1200
350	*Al.-Ch.	ARYW	1800
300	Cr-Wh	SR70-R	1800
250	Al.-Ch.	ARY-826	1800
250	*G.E.	I-M-17A	720
200	G.E.	I-M-16	600
200	*West.	CW1950A	514
180	Cr-Wh	SR-50R	1800
150	G.E.	I-M-15A	900
125	G.E.	I-M-15A	600
100	G.E.	I-E-18A	1800
100	G.E.	MT558	720
100	G.E.	I-M-15A	425
75	West.	CW-770	1200
75	G.E.	MT-847	1200
75	G.E.	MT-856	900
75	G.E.	MT-852	720
75	G.E.	I-M-16	600
60	G.E.	MT-836	1200
60	*West.	CW-7920	900
50	*G.E.	MT-836	1200

WRITE FOR CURRENT STOCK LIST

CHICAGO *Electric Co.*

ALL TYPES OF EQUIPMENT IN STOCK

1320 W. CERMAK RD. • CHICAGO 8, ILL. • PHONE: CANAL 6-2900

FOR SALE—EXCEPTIONAL BARGAINS

Diesel Generator Units, 200 KW-1500 KW — Turbo Generators, 500 KW-10,000 KW
Motor Generator Sets—Rotary Converters—Synchronous Condensers—
Frequency Changers—Transformers—Pumps, Boilers.

UTILITIES MACHINERY CORPORATION

1965 East Sixth St., Cleveland 14, Ohio • PHONES: CHerry 1-0210 & CH 1-4070

New and Used Equipment Available for
POWER PLANTS, SUBSTATIONS, TRANSMISSION LINES AND CONSTRUCTION
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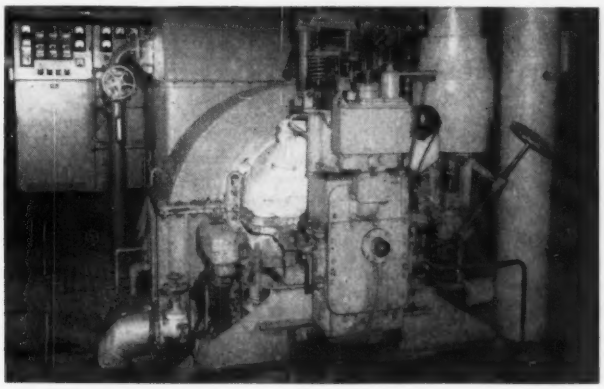
EBASCO SERVICES INCORPORATED

APPARATUS EXCHANGE — Two Rector St., New York 6, N. Y.

CHARLES WEAVER – *Presents!*

2250 KVA G.E. Turbine Generator



Initial Steam—410 PSIG
750° FTT

Condensing 28″ Vacuum

Electrical Conditions
3/60/2400 V.

Surface condenser
3800 Sq. Ft.

Complete Auxiliaries

Switchboard & Dual Drive Exciter

New 1944

400 Lb. Pressure 750° G.E. Turbine Generator

2500 KW @ 70% P.F.

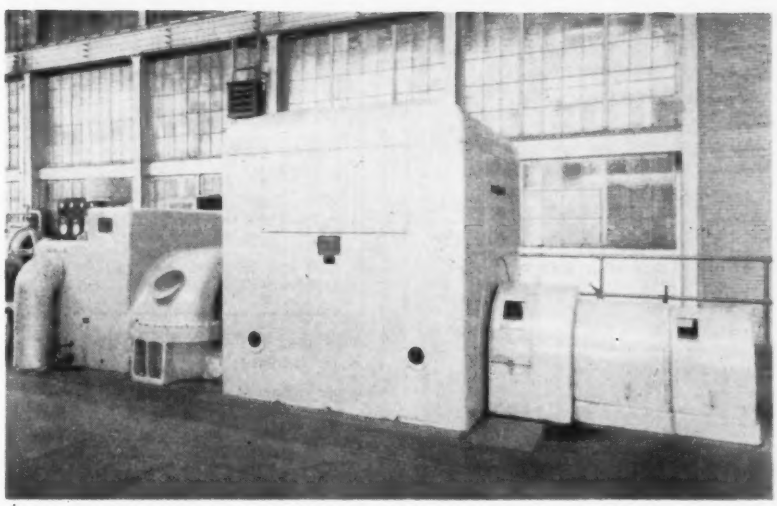
Condensing 28″ Vacuum

Automatic Extraction
25 PSIG

Surface Condenser and Auxiliaries

Switchboard complete

New 1949



IMMEDIATELY AVAILABLE

A COMPLETE LINE OF BOILERS AND DIESEL ENGINES ALSO IN STOCK
Any Additional Data Desired will be Cheerfully Furnished

Cable Address:
CHASWEAVER

CHARLES WEAVER, INC.
19701 JAMES COUZENS HIGHWAY
DETROIT 35, MICHIGAN

Telephone:
BRoadway 3-1900

37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	900
450	440	Whse.	514
400(2)	2300	G.E.	900
400	4000/2300	Whse.	720
300	4000/2300	G.E.	720
300	2300	G.E.	900
300	440	G.E. (hoist)	600
300	440	Whse.	3600
225	4000/2300	G.E. (hoist)	600
200	2300	G.E.	600
200	2300/440	G.E.	720
150	230/440	Whse.	720
125	2300	G.E.	600

AC GENERATORS or SYN. MOTORS, 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G.E.	ATI	720
300	2300/460	G.E.	TS	720
300	2200/440	G.E.	TS	1200
200	2300/440	Whse.	G	1200
150	440/220	Whse.	G	1200
150	440/220	G.E.	TS	900
125	440/230	Whse.	HR	400

SQUIRREL CAGE MOTORS

500	2200/4000	Elliott	SC	1800
400	2300	G.E.	FT	3600
350	2300/440	G.E.	IE-K	1200
300(2)	2300	G.E.	FT	3600
200	2300/4000	L. Allis	FS	1800
200	440/220	G.E.	KT	1800
200	2300	G.E.	KT	1800
200	2300	Cent.	TEFC	3600
200	440/220	G.E.	KT	720
200	2300/440	G.E.	IE-K	1200
150	440	Whse.	X-prf.	3600
150	2200	Al. Chal.	KT	720
150	440/220	G.E.	TEFC	720
150	2200/440	G.E.	AR	1800
150	2300/440		KT	900
150	2200/440	G.E.	FT	1200
125(2)	2200/440	Whse.	X-proof	720
125	2200/440	G.E.	K	600
100(3)	4000/2300	L. Allis	OX	1200
100	2300	Cent'l.	TEFC	3600
75(2)	440	Wagner	TEFC	1800

CIRCUIT BREAKERS, 3 Pole

1—6000 Amp., Whse., 600 V., Air, New
1—2000 Amp., R-Smith, 600 V., Air, New
4—1200 Amp., DA-50, Whse., 600 V., Air
6— 600 Amp., R. Smith, 7.5 KV, Sol. oper.
1— 400 Amp., R. Smith, 7.5 KV, outdoor, New

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
200	230	Cr. Wh.	CMC	1200
150	230	El. Dyn.	B/brg.	600
125	230	G.E.	CD	600
60/75	230	G.E.	CD	500/1500

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	440	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
125	G.E.	440	Sq. Ca.	250/125
100	G.E.	2200/440	Syn.	250
75	Cr. Wh.	440/230	Sq. Ca.	240/120
65	G.E.	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—500 kva, Al. Ch., 2400/4160Y—600 volts, 3 ph.
3—333 kva, G.E., 13,800—2300 V.
3—333 kva, G.E., 2400-240/480 V.
3—250 kva, Al. Ch., 13,800—440/480 V.
1—200 kva, Al. Ch., 6900—220 V., 3 ph.
3—200 kva, Whse., 4600/2300—230/115 V.
1—200 kva, G.E., 2400—120/240 V., Pyr.
3—200 kva, Mol., 13,800—2300 V.
3—200 kva, G.E., 13,800—480 V.
3—150 kva, Al. Ch., 2400—220 V.
3—150 kva, Al. Ch., 440-220 V., dry New
3—150 kva, G.E., 13,200—2300 V.
3—100 kva, Whse., 4800/2400-240/480 V., Dry
3—100 kva, G.E., 2400—120/240 V., Pyr.

GASOLINE—ENGINE GENERATOR SETS

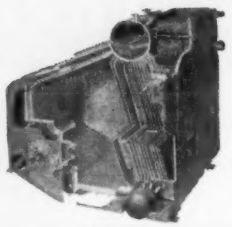
2—35 kva, 900 R, 220 V, 3 ph. conn. LaRol, 6 cyl.
(1) 9.4 kva, 1200 rpm 120/240 V, 1 ph, Cent, 6 cyl.

only partial listing

STEPHEN HALL & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

BOILERS

NEW UNASSEMBLED



# Steam/hr.	Key	PSI	Temp.
122,500	DF	565	850
121,650	DF	565	850
60,000	SF	435	750
74,000	H	280	500
55,000	A	240	—

DF Double Furnace, SF Single Furnace (illustrated), bent water tube boilers w/economizers and superheaters, B & W's and Foster Wheelers.

H. Header type, straight tube, B & W.

A 3 drum, single furnace, Wickes.

Pelnik-Loconti Industrial Supply Co.
315 Oriskany St., Yorkville, N.Y.
Utica, N. Y. Phones 6-4621, 2-4513

TRANSFORMERS—60 CYCLE

Qu	KVA	Make	Type	Phase	Voltages
2	3000	Maloney	TCR	3	7200/6900-4160/2400
2	750	G.E.	K	1	4800-120/240
1	500	West.	Power Ctr.	3	2400/4160Y-120, 240 240 or 480
1	300	Penna.	(Askarel)	3	13470Y/7800-240
2	250	G.E.	H Pyranol	1	4800/2630Y/120/240
2	250	West.		1	2300/4600-230/460
1	200	G.E.	H	1	7960-15600-120/440
1	150	Ehler	OA	1	4160-240/480
3	100	G.E.	H		2400/4160-240/480
1	50	G.E.	Air Cooled	1	440/220-220/110
3	50	G.E.	HS	1	2400/4160-240/120
1	50	Amer.	Abestol	3	4160-120/208Y
5	50	G.E.	HS	1	2400/4160-240/480
4	25	West.	Hypersil	1	2400/4160-120/240
3	15	West.	H Pyranol	1	6900/11950Y-120/240

MOTOR GENERATOR SETS

Qu	KW	Make	Speed	DC	AC
3	60	E.M.	1200	125	220 v. Syn.
1	75	G.E.	1200	125	2300/4160 Syn.
3	100	West.	1200	250	2300/4160Y Syn.
1	175	West.	1200	125	4150 Syn.
1	300	G.E.	1200	250	2300/4160Y S.R.
1	300	G.E.	1200	250	440 Sync.
1	1000	West.	720	600	2300/4160Y

ENGINE GENERATOR SETS

1—Hercules Gas HXE 62.5 KVA Westghe 3/60/450 —1200
1—Wisconsin Gas (Air) PB-30 7.5 KVA Master 1 or 3/120—2300 r.p.m. NBW.

SLIP RING MOTORS

Qu	HP	Make	Speed	Type	Volts
2	40	West.	600	OW	220/440
1	60	G.E.	1800	MT	220
1	75	G.E.	600	IM	440
1	100	West.	1800	T.B.F.C.	B.B. 220
3	150	Allis-Ch.	1800	AY-RW	2300
1	200	West.	514	OW	440
1	250	West.	600	CW	440
1	350	West.	1200	CW	2300
1	500	G.E.	450	MT	2200
1	500	G.E.	1200	M569Z	2300/4160Y

D.C. MOTORS—230 VOLTS

Qu	HP	Make	Speed	Type
1	30	West.	1750	SK 113
1	75	Star	1200	SB 60 L B.B.
1	350	G.E.	1200	Pedestal

SQUIRREL CAGE MOTORS, 3 PHASE, 60 CYC.

1—275 HP, 1180 RPM G.E. Type KT 569BS 2200V
2—200 HP, 1790 RPM, G.E. Elec. KP, TEFC, 2300V
1—401P, 1750 RPM Wagner 444 440V T.E.F.C.
1—251P, 1170 Howell 405 440V T.B.F.C.

MOTORS—SYNCHRONOUS—3 ph. 60 cy.

125 HP 600 RPM G.E. Type TS 2200 V.
125 HP 900 RPM G.E. Type TS 4800 V.
150 HP 1800 RPM G.E. Type TS 220 V.
225 HP 900 RPM West—2300 V.
300 HP 720 RPM Elec. Machinery t.e.f.c. 2300 V.
400 HP 450 RPM Westinghouse Type HR 440 V.
1000 HP 360 RPM Westinghouse Ped Type 2300 V.

"FOR POWER"
J.L. HEMPHILL & CO.
1602 54th STREET, NORTH BERGEN, N. J.
PHONE NEW YORK—LONGACRE 5-3222
PHONE NEW JERSEY—UNION 3-2600

COMPLETE NEW PLANT 4600 KW TURBO GENERATOR

GE Generator Type ATB-2, 3/93-1/3/2700 volts — 5600 RPM (Also 2950 KW 3/60/1700 volts @ 3600 RPM). GE Turbine 410 PSI @ 724°F, with 3800 sq. ft. surface condenser.

NEW MOTORS

1500 HP DC Westinghouse 525 Volts — 600 RPM.

6000 HP AC G.E. 3/93—1/3/2700 Volts—400 RPM reversible, (also 3800 HP @ 3/60/1700 volts—257 RPM).

4600 KW GE Generator 3/93—1/3/2700 Volts (also 3/60/1700 Volts).

NEW FEED WATER HEATERS, Struthers & Wells, 206 sq. ft.

NEW DEAERATING HEATERS, Elliott 246,000#/hr, 1000 gal. capacity.

NEW CONDENSERS from 400 sq. ft. to 11,000 sq. ft.

POWER PLANT DISMANTLING SPECIALISTS
INSURED REMOVAL — ANYWHERE
HIGHEST PRICES FOR YOUR EQUIPMENT
HIGHEST PRICES FOR YOUR SCRAP

EASTERN SCRAP & SALVAGE CORPORATION
65 Muirhead Avenue
Trenton 7, New Jersey

DIESEL GENERATOR SETS

1250 KW Cooper-Bessemer Dual Fuel, 1650 HP, 327 RPM, supercharged. Westinghouse 3/60/2300 generator with all accessories. New 1949.

400 KW General Motors Quad portable diesel generator. 650 HP. Skid mounted radiator cooled. Westinghouse 3/60/2300 generator, complete, used 60 days.

Both units in excellent condition. Priced attractively.

WHISLER EQUIPMENT COMPANY
611 Olive St. St. Louis 1, Mo.
CHestnut 1-4474

BAGASSE BOILERS FOR SALE

1—80,000# Hr. 250 Psi Connelly, 1923
1—120,000# Hr. 250 Psi Union Iron Works
2—40,000# Hr. 250 Psi Union Iron Works

BOILERS WANTED

B&W sectional header type
Stirling type boilers

Midwest Boiler & Turbine Co.
520—5th Avenue, New York 36, N.Y.
Equipment dismantling contractor.

SUB-STATION EQUIP. FOR SALE

3 Moloney 150 KVA Transformers 4000/6900 HV 230/460 LV 60 cycle.

1 Moloney 87½ KVA 60 cy. 2000/4000. HV 115/230 LV Also Switches. Arrestors, Etc.

LAMBERT NOVELTY MIRROR WKS., INC.
6200 Maple St. Louis 14, Missouri

FOR SALE

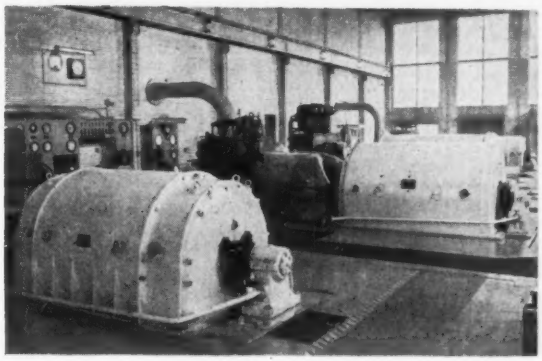
SURPLUS ELECTRICAL EQUIPMENT

Dozens of pieces of electrical equipment—motors, generators, etc. Some new, some used, but with a lot of good service still ahead of them. For complete listing and full details contact

Purchasing Department, Section C
Box 570, Savannah, Georgia

SPECIAL OFFERING!

650 lb., 725 DEG TURBO GENERATORS — Still on Original Foundations As Shown in Photo Below — All Westinghouse, 3600 RPM, 80% P.F., 6900 V, 3/60.



1—9375 KVA, 7500 KW, 125 P.S.I.G. auto extraction, surface condenser, installed in 1937.
1—9375 KVA, 7500 KW, non-condensing, 125# B.P., installed 1930.
1—6250 KVA, 5000 KW, Condensing, with surface condenser, installed 1942.

•

BELYEA CO. INC.

43 HOWELL STREET — JERSEY CITY 6, N. J.

N. J. Phone: OLdfield 3-3334
N. Y. City Phone: REctor 2-7150

BREWERY EQUIPMENT LIQUIDATION SALE!

The following equipment is still erected as last used and is available for immediate inspection and delivery at tremendous bargains! Inspection is invited.

FORT PITT BREWERY
SHARPSBURG (PITTSBURGH), PA.
Telephone: Sterling 2300

2—Babcock & Wilcox Sterling bent-tube boilers, Class 42 #20, 635 HP ea., new 1941, four drums, 430—3¼" tubes, 6340 sq. ft. heating surface, 160-lb. working pressure, including chain, grate stoker, one set of water-cooled furnace walls, one set of Diamond soot blowers, 4-strap fan stokers, motor for stoker, super heaters, feed pumps, etc. The complete installation!

1—G.E. AC generator, Type ATV-2-625; KVA-3600, PF 80, 3-phase, 500 kilowatts, 2300 volts, 3600 speed, 60 cycle, coupled to a G.E. turbine #37381, 500 KW, 3600 RPM, 6-stage, Form L, 165-lb. steam pressure, with Elliott surface condenser; also included is an Ingersoll Rand centrifugal pump, complete installation, everything hooked up as used up until a few months ago when this brewery ceased operations.

RED TOP BREWERY, PLANT #2
CINCINNATI, OHIO
242 W. McMicken Ave. Tel: Cherry 1-3400

1—B & W Sterling boiler, new 1937, four drums, 336—3¼" dia. tubes, 3458 sq. ft. heating surface, 350 HP, 160-lb. pressure, State Registration No. 60465.

1—B & W Sterling water-tube boiler, 1934, 3-drum, 210—3¼" dia. tubes, 2046 sq. ft. heating surface, 200 HP, 160-lb. pressure, State Registration No. 57892.

This equipment installed at the Red Top Plant as last used up until the time the brewery ceased operations a few weeks ago.

In both cases, communicate with the breweries for additional information and option for inspection. Offers are subject to prior sale.

MISS POWER EQUIPMENT SAYS,

"For BIGGER SAVINGS and BETTER SERVICE, Get Our BARGAIN PRICES on Guaranteed New and Rebuilt Motors"

SQUIRREL CAGE MOTORS
NEW AND GUARANTEED REBUILT

HP	Make	Type	Speed
400	West. S.B. Drip	OSP-681S	1800
400	West. S.B. Open	CS	900
400	West. S.B. Splash	CS-398	720
	2300 Volt		
350	A.C. S.S. Drip	ARWW-626	3600
300	G.E. S.B. Open	IK	1800
300	G.E. S.B. Open	IK	900
300	G.E. S.B. Open	IK	720
300	West. S.B. Open	CS-1002	600
250	G.E. S.B. Open	KT	1800
250	G.E. S.B. Open	IK-16	1200
	2200 V		
250	G.E. S.B. Open	IK	1200
250	G.E. S.B. Open	IK	900
250	G.E. S.B. Open	IK	720
200	G.E. B.B. Drip	K-6325	1800
200	Cont. T.E.F.C. B.B.	NP-586C	1800
200	C.W. B.B. Drip.	SC-86A	1800
200	G.E. S.B. Open	IK-15	1200
200	G.E. S.B. Open	IK-158	1200
200	G.E. S.B. Open	IK	1200
	2200 V		
200	G.E. S.B. Open	IK	900
150	West. TEFCBB XP	CS-773.6	3600
150	G.E. TEFCBB	K-6328	3600
150	G.E. TEFCB XP	K	3600
150	G.E. TEBB	K	1800
150	West. S.S.B. Open	CS-778C	1800
150	West. S.B. Open	CS	1800
	2200 V		
150	G.E. S.B. Open	IK	1800
150	West BB Open	CS-771C	1800
150	G.E. B.B. Open	KT	1200
150	Cont. T.E.F.C. B.B	New	900
150	Ideal B.B. Open.	New A-585	1200
150	G.E. S.B. Open	KT-558	900
150	G.E. S.B. Open	IK	720
125	West. TEFCBB	CS-580C	900
125	G.E. S.B. Open	FT-543	3600
125	G.E. TEFCBB	K	3600
125	West. S.S.B. Open	New CS-607	1800
125	G.E. S.B. Open	IK	1800
125	West. S.S.B. Open	CS	1800
125	El. Dyn. B.B. Drip	KNX-222	1800
125	G.E. S.B. Open	KT-553	1200
125	G.E. S.B. Open	IK	1200
125	G.E. S.B. Open	IK	900
125	G.E. S.B. Open	IK	720
125	G.E. S.B. Open	IK	600
100	Howell TEFCBB	K-505	3600
100	Wag. TEFCBB	CP-635	1200
100	West. B.B. Splash.	CS-754C	900
100	G.E. S.B. Open	KT-356	900
100	El. Dyn. T.E.F.C.B.B.	XP KNX-223	1800
100	G.E. S.B. Open	KT-343	1800
100	A.C. S.B. Open	2200 V ARX	1800
100	L.A. TEFCBB	JX-113	1800
100	West. S.S.B. Splash	CS-770.3	1200
100	G.E. B.B. Open	K-504	1800
100	G.E. S.B. Open	KT-347	1200
100	West S.B. Open	2200V CS-774C	900
100	G.E. S.B. Open	IK	900
75	West. B.B. Drip.	CS-642C	1200
75	West. B.B. Splash.	440V CS-445	3600
75	West. BB Splash	CS-445	3600
75	West. TEFCBB	CS-505	1200
75	Cont. TEFCBB	AF-109X	900
60	L.A. TEFCBB	XP EX-445	3600

CASH
FOR YOUR
SURPLUS
NEW & USED Electrical Equipment

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FREE CATALOG. This is a partial listing. We are continually changing our stock, and can fill your requirements at any time. Send for our free catalog. In Stock, fractional horsepower up to 500.

Large line of motors. Control Equipment, AC and DC Generators, MG sets and transformers. PHONE or WIRE us COLLECT

POWER EQUIPMENT CO.
8 CAIRN STREET • PHONE BEverly 5-1662 • P.O. BOX 534 • ROCHESTER 2, N.Y.

CHECK WITH WAGNER FIRST!

Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P. OUR 52nd YEAR

A. C. MOTORS—60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
700	Whse.	Slipring	2300/4000	1200
600	Elliott (2)	Sq. Cage	2300	900
500	Allis Ch.	Slipring	2300/440	600
400	Whse. (2)	Synch.	2200	1800
400	Whse.	Sq. Cage	2300	514
400	Marathon (2)	Sq. Cage	2300	3600
400	Whse.	Sq. Cage	2300	900
400	G.E. (2)	Slipring	440	900
400	G.E.	Slipring	2300	514
400	El. Machy.	Synch.	440	600
350	Br. Boveri b.b.	Sq. Cage	4800/480	720
350	G.E.	Sq. Cage	2200	1800
350	G.E.	Slipring	440	1200
350	Allis Ch.	Slipring	2200/4000	600
300	El. Machy (2)	Synch.	2300/440	720
300	G.E.	Slipring	2200/440	690
300	G.E. (2)	Synch.	2200/440	360
300	Whse.	Slipring	2300	514
300	Whse.	Synch.	440	1200
250	G.E.	Sq. Cage	2200/440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E.	Sq. Cage	2200	1800
250	Whse.	Sq. Cage	2300/440	600
200	G.E.	Slipring	440	600
200	L.A. TEFC	Sq. Cage	440	1200
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Allis Ch.	Slipring	2200/440	720
200	Whse.	Sq. Cage	2200/440	900
175	G.E. (2)	Synch.	220/440	720
150	Rel TEFC	Sq. Cage	220/440	900
150	G.E. (4)	Slipring	2200/440	600
150	Cr. Wheeler	Sq. Cage	220/440	450
150	G.E. 2)	Sq. Cage	2200/440	1800
150	Whse.	Slipring	220/440	1200
125	G.E. T.E.F.C.	Sq. Cage	2200	3600
125	Al. Ch. TEFC	Sq. Cage	220/440	600
100	Whse. TEFC	Sq. Cage	220/440	900
100	Smith b.b. (6)	Sq. Cage	220/440	1800

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
200	Gen. Elec.	RC	250	1450
150	Whse.	SK-184	250	1150
150	Cr. Wh.	CCD	250	650
100	Cr. Wh.	CCD-65H	125	1200
100	Reliance	651-T	600	1200
75	Gen. Elec.	CD-123	125/250	1540
60	Allis Ch. (3)	E-146	250	1500
60	Ideal	D	125	1150
25	Whse.	SK-163	250	1750

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Whse.	CB-509	250	575/1150
250	Cr. Wh.	101-H	230	1150
200	G.E. (2)	RC-38	230	1150
200	Whse. b.b.	SK	250	287/575
150	Whse.	SK-184	230	850
150	Whse.	SK-210	230	320/1000
125	G.E.	CD-173	230	575/1150
100	Elliott b.b. T.E.	JH-FE	230	1150
75	Whse. (4)	SK-163	230	500/1500
60	G.E. TEFC b.b.	CD-135	230	1150
50	Century	DN-514	230	1150/1750
50	G.E.	RF-16	230	250/1000
50	Reliance b.b.	310-T	230	600/1500
40	G.E. (2)	CD-93	230	1750
40	Whse. b.b. (2)	SK-163	230	380/1200
25	Whse. 2)	SK-153	230	300/1200

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
600	Allis Ch.	440 AC	250 DC
300	Whse. (2)	2200/440 AC	250 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	G.E.	220/440 AC	600 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
75	Star b.b.	220/440 AC	250 DC
75	G.E.	200/440 AC	125 DC
60	Allis Ch.	220/440 AC	250 DC
50	Cr. Wh. b.b. (2)	220/440 AC	250 DC

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MO nroe 6-7409

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300 KW G.E. Non-C Turbo-Generator
3/60/480—150# 5-10# BP 3600 RPM

2000 KW GE N.C. Ext. Turbo-Gen.
480V, 600#.650° 150# Ext. 30# B.P.

45000# Combustion Engineering BOILER
450# 750°TT oil fired

21000# Babcock & Wilcox BOILERS (2)
450# 625°TT oil fired

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382 Wayne St. Jersey City, N. J.
Phone: DElaware 2-8300

TRANSFORMERS

Qu.	KVA	Make	Type	Ph	Pri Volts	Sec Volts
3—	25	G.E.	OISC	1	12,000	240/480
2—	25	G.E.	OISC	1	6900/720	240/480
2—	25	G.E.	OISC	1	4800/8320Y	120/240/480
1—	25	Penn.	OISC	1	4800	240/480
2—	25	West.	OISC	1	2400	120/240
3—	50	Al. Ch.	OISC	1	7200	240/480
3—37½		Stand.	Pyranol	1	2400/4800	120/240
1—37½		G.E.	OISC	1	6900	115/230
1—37½		G.E.	OISC	1	2400	120/240
2—37½		G.E.	OISC	1	2300	115/230
1—	50	G.E.	OISC	1	2400/4800	120/240
1—	50	G.E.	OISC	3	4800	240/480
3—	50	Kuhlman	OISC	1	2400/4160	120/240
3—	50	G.E.	OISC	1	2400/4160	120/240
3—	50	A.C.	OISC	1	2400/4160	240/480
1—	50	A.C.	OISC	1	2400	120/240
3—	75	Al. Ch.	OISC	1	33,000	2400/4160Y
3—	75	G.E.	OISC	1	2400/4160Y	120/240
2—	75	G.E.	OISC	1	4160	120/240
3—	75	G.E.	OISC	1	4160	120/240
1—	100	Al. Ch.	OISC	1	4800	120/240
1—	100	Al. Ch.	OISC	1	4800	240/480
2—	100	G.E.	OISC	1	2400	240/480
3—	100	West.	OISC	1	2400/4800	240/480
3—	100	West.	OISC	1	4160	120/240
3—	100	West.	OISC	1	4800	240/480
3—	150	Moloney	OISC	1	4800	240/480
3—	150	Penn.	OISC	1	2400/4800	240/480
2—	167	Niagara	OISC	1	4800	240/480
2—	150	Al. Ch.	OISC	1	2400	120/240
1—	150	G.E.	Dry	3	480	120/208Y
3—	150	G.E.	OISC	1	2400	240/480
3—	150	G.E.	OISC	1	2400/4160Y	240/480
3—	150	Al. Ch.	OISC	1	12,000	4800/8320Y
3—	200	G.E.	OISC	1	4160/4800	240/480
3—	200	G.E.	OISC	1	12,000	4800/8320Y
3—	250	G.E.	OISC	1	2400/4800	240/480
2—	350	American	OISC Auto	1	440/240	20/40
3—	833	Al. Ch.	OISC	1	11,000	480
3—	667	G.E.	OISC	1	2400/4160Y	600/480
2—1000		Penn. Pur.	OIWC	1	12,000	60/55/50/45 Will Change
1—	100	G.E.	Dry	1	480	120
3—	25	Al. Ch.	Dry	1	240/480	120/240
3—	25	West.	Dry	1	240/480	120/240
3—	100	West.	Dry	1	2400	120/240

General Electric Outdoor 3 Pole Oil Breaker Type—FKO-37 400 Amps—15000 Volts,

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125 HP Portable Steam Generator
445 CFM & 9x9 Mtr. Driven Compressors
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217 HP Kewanee Boiler Oil & Gas Fired
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30,000 pound steam per hour Combustion Engineering boiler, type VU, two drum, bent tube, 450# steam pressure, 825° FTT, complete with spreader stoker and automatic control.

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268 CFM 500 psi 10-4¼x10 Ing.
465 CFM 100 psi 12x11 Ing.
502 CFM 125 psi 12x13 Worth. H.B.
585 CFM 100 psi 15-9¼x12 Ing. XRE 3-60-4160
590 CFM 100 psi 13½-8x8 Penn DE2 3-60-220
628 CFM 100 psi 14x13 Worth HB
676 CFM 100 psi 15-9¼x12 Ing. XRB—Worth.
860 CFM 125 psi 13-8x7 Jay WN102
920 CFM 110 psi 18-11x12 GP-OCE
973 CFM 25 psi 16-10x7 Ing XLE
1352 CFM 125 psi 18½-11½x8 Ing XLE
2832 CFM Vae 31x13 Ing ES
7950 CFM 200 psi 33-17¾x27 IR-PRE2-4C

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200′	4″	Sch	80 — Gr P1
25′	6″	Sch	40 — Gr P1
180′	8″	Sch	40 — Gr P1
23′	8″	Sch	30 — Gr P1
422′	3″	Sch	160 — Gr P2
51′	4″	Sch	120 — Gr P2
110′	6″	Sch	40 — Gr P2
67′	8″	Sch	40 — Gr P2
22′	10″	Sch	100 — Gr P2
20′	16″	Sch	100 — Gr P2
68′	2½″	Sch	40 — Gr P5
140′	2½″	Sch	80 — Gr P5
87′	3″	Sch	40 — Gr P5
200′	3″	Sch	80 — Gr P5
200′	4″	Sch	40 — Gr P5
160′	4″	Sch	80 — Gr P5
33′	6″	Sch	40 — Gr P5
25′	6″ Dble Ex Hy		— Gr P5
17′	6″	Sch	160 — Gr P5
110′	8″	Sch	40 — Gr P5
113′	8″	Sch	80 — Gr P5
12′	8″	Sch	160 — Gr P5
187′	10″	Sch	60 — Gr P5
300′	2½″	Sch	80 — Gr P11
550′	3″	Sch	40 — Gr P11
460′	3″	Sch	80 — Gr P11
340′	3″	Sch	160 — Gr P11
85′	4″	Sch	40 — Gr P11
600′	4″	Sch	80 — Gr P11
120′	4″	Sch	160 — Gr P11
47′	4″ Dble Ex Hy		— Gr P11
23′	5″	Sch	160 — Gr P11
70′	6″	Sch	40 — Gr P11
440′	6″	Sch	80 — Gr P11
1800′	6″	Sch	160 — Gr P11
50′	6″ Dble Ex Hy		— Gr P11
300′	8″	Sch	40 — Gr P11
1070′	8″	Sch	80 — Gr P11
1345′	8″	Sch	160 — Gr P11
41′	8″ x 1.264″ Nom. Wall		— Gr P11
25′	8″ x 1.25″ Nom. Wall		— Gr P11
1080′	10″	Sch	60 — Gr P11
1076′	10″	Sch	80 — Gr P11
28′	10″	Sch	120 — Gr P11
43′	10″	Sch	160 — Gr P11
53′	10″ x 1.563″ Nom. Wall		— Gr P11
95′	12″	Sch	80 — Gr P11
98′	12″	Sch	100 — Gr P11
24′	12″	Sch	120 — Gr P11
324′	14″	Sch	80 — Gr P11
22′	14″ x 1-13/16″ Nom. Wall		— Gr P11
170′	16″	Sch	80 — Gr P11
32′	16″	Sch	100 — Gr P11
17′	24″ x ⅜″ Nom. Wall		— Gr P11
88′	3″	Sch	160 — Gr P12
20′	5″	Sch	40 — Gr P12
180′	5″	Sch	160 — Gr P12
27′	6″	Sch	80 — Gr P12
31′	8″	Sch	100 — Gr P12
55′	8″	Sch	20 — Gr P12
22′	8″	Sch	40 — Gr P12
54′	10″ x 7/16″ Nom. Wall		— Gr P12
33′	24″	Sch	40 — Gr P12
225′	3″	Sch	80 — Gr P22
780′	4″	Sch	40 — Gr P22
86′	4″	Sch	80 — Gr P22
50′	6″	Sch	80 — Gr P22
46′	6″ x 1.10″ Nom. Wall		— Gr P22
330′	8″	Sch	80 — Gr P22
12′	8″ x 1.212″ Nom. Wall		— Gr P22

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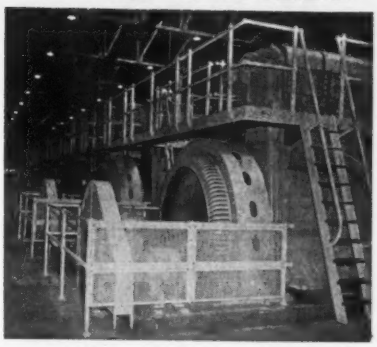

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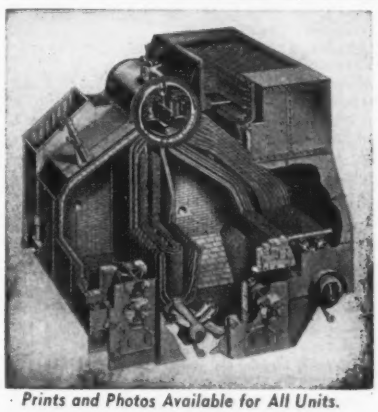
Will be sold individually or as a complete unit. **TURBINE**—9 Stage, Non-Condensing, Automatic Extraction, 600 PSIG, 600° FTT, 150# Extraction, 30# Back Pressure, 3600 RPM, direct connected to **GENERATOR**—2000 KW 3/60/480 Volts complete with Controls. **BOILER**—4 Drum Bent Tube, 75000#/hr. 650 PSIG, 650° FTT with Water Walls, Oil Fired complete with Fans and Feed Water Pump.

1875 KVA

STILL INSTALLED. Will be sold as complete unit or piece by piece. **TURBINE**—400 PSIG, 700°FTT with Surface Condenser and Pumps, direct connected to **GENERATOR**—1875 KVA, .8PF, 3/60/2300/3600 RPM, complete with Controls. **BOILER**—25,000 #/hr 450 PSIG, 738° FTT, Stoker Fired with Superheater, Fans, Feed Pumps. **AUXILIARIES**—Deaerating Heater, Coal Crusher, Elevator and Conveyors. **CRANE**—25 Ton, 36′ Span.



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44,500	450	735
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2—250 KVA, 1/60/2400-240/480 Moloney OISC, type YC, with taps
1—250 KVA, 4—150 KVA, and 2—100 KVA 1/60/4160-240/120 Whse. Inertean with taps
1—200 KVA 3/60/4160-240 Wagner, ITE type RPB Unit Substation, Outdoor.
3—15 KVA, 1/60/240-480/120-240 Sorgel Dry

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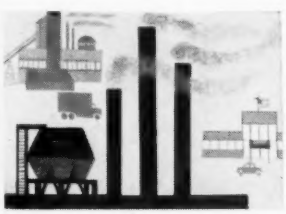
Worthington Corporation, Harrison, N. J. In Canada, Worthington, Ltd., Brantford, Ontario

NEW sales organization . . . serves both direct and distributor sales, is geared to customer needs.



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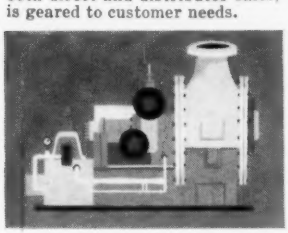

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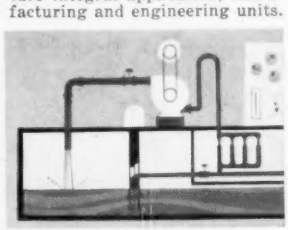

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